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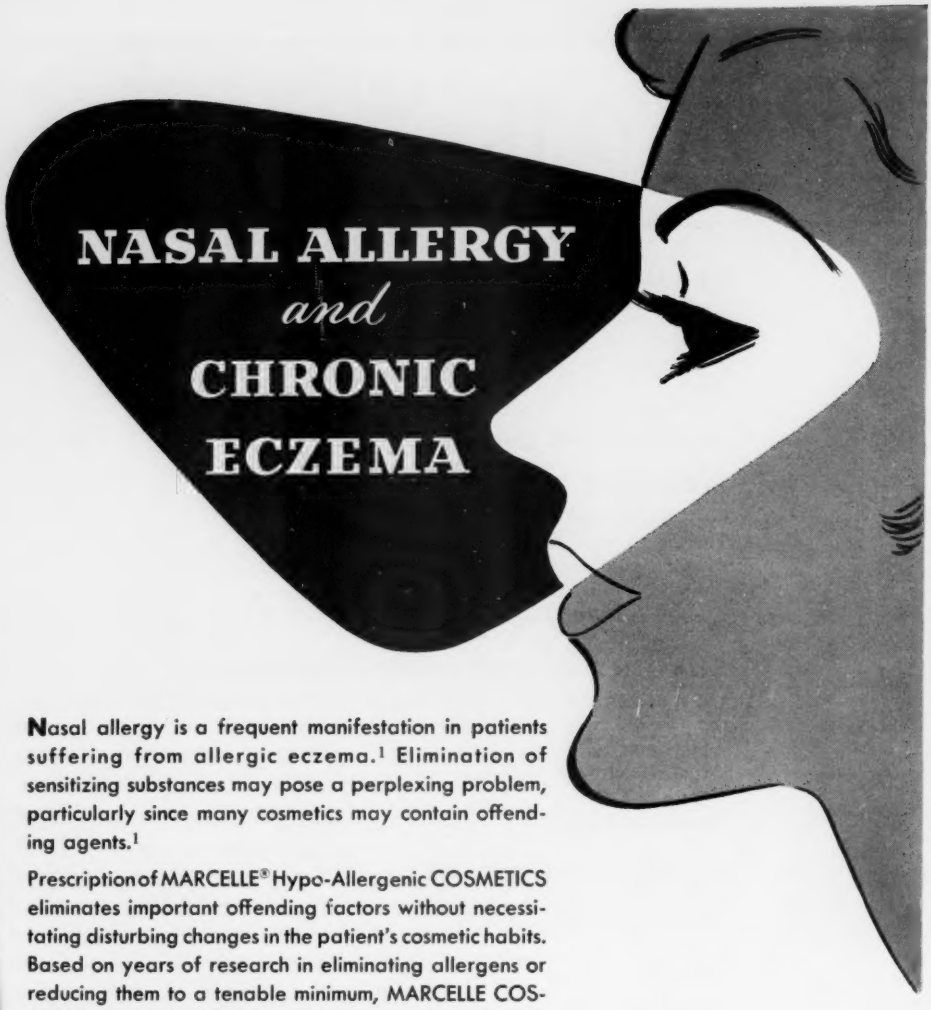

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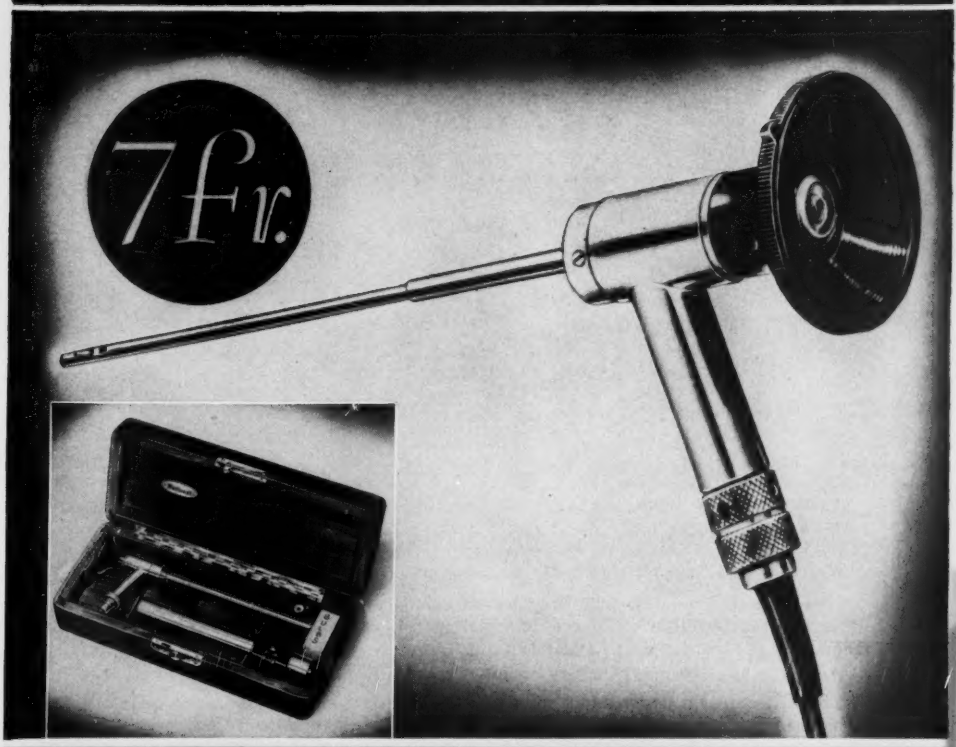


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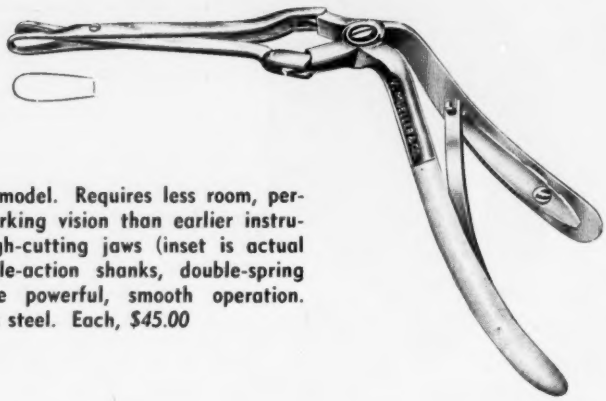

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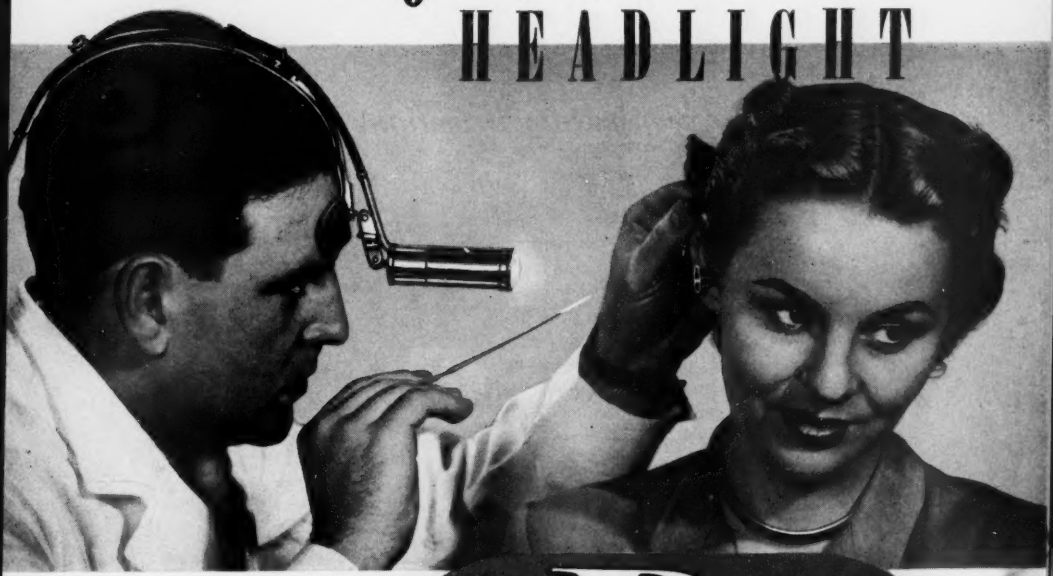

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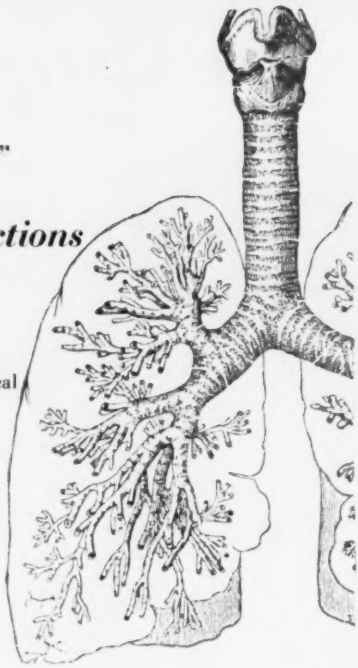

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1. *Herrell, W. E.; Heilman, F. R., and Wellman, W. E.: Ann. New York Acad. Sc. 53:448 (Sept. 15) 1950.*
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ARCHIVES OF OTOLARYNGOLOGY

VOLUME 53 MARCH 1951 NUMBER 3

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# A STUDY OF LONG TERM HEARING RESULTS IN FENESTRATION SURGERY

LOUIS E. ADIN Jr., M.D.
DALLAS, TEXAS
AND
GEORGE E. SHAMBAUGH Jr., M.D.
CHICAGO

OF THE several controversial points regarding the results of fenestration surgery, the permanency of the hearing result and the possible effect of the operation on the progressive nature of the disease are certainly not the least significant. In an attempt to find an answer to these questions, a careful study was made of 390 cases of fenestration, which have been followed for five to 10 years.

These cases were chosen from a total series of 743 fenestrations performed between July 1940 and July 1945 at the Wesley Memorial Hospital, Chicago, with use of the continuous irrigation and binocular dissecting microscope technic devised by Shambaugh at Northwestern University.[1] The cases were chosen chronologically on the basis of whether the records were complete over at least a five year period, and no cases were included in which there had not been follow-up examinations by repeated audiograms and clinical observations for that minimum period.

It might be suggested that the results of such a series would be altered by the refusal of patients with a poor result from the operation to return for postoperative checkup, but this supposition does not seem to be the case. Those patients who did not receive serviceable hearing from the operation were, apparently, as apt to return as the others. In fact, any deviation from the true results because of such a factor would be more than compensated for by the large number of patients who obtained a good result from the operation and did not return regularly because of absence of any trouble.

The age of the patients ranged from 12 to 74 years at the time of operation, but the fourth and fifth decades of life accounted for the majority (table 1). The patients were classified preoperatively as to suitability for the fenestration operation on the basis of the findings of air and bone conduction audiometry and tuning fork testing. If the hearing loss was due solely to partial or complete stapedial fixation without any secondary nerve degeneration involving the critical speech frequencies, the patient was given a class A, or ideal suitability, designation. If there was slight to moderate nerve change for 2048 cycles per second, class B suitability was the designation, and if there was nerve degeneration for two or all three of the most important speech frequencies, class C, borderline, was the designation. The strict specifications for these preoperative classifications have been

1. Juers, A. L., and Shambaugh, G. E., Jr.: The Evolution of the Northwestern University Fenestration Technic, Quart. Bull. Northwestern Univ. M. School, **23**:1, 56, 1949.

laid down elsewhere.[2] Table 2 shows the distribution of the three preoperative classifications among the total cases studied.

It became evident, as the cases were being reviewed, that the long term hearing results fell into four distinct groups. Fortunately, the group in which there was no significant gain in hearing at any time after the operation was small, 5.6 per cent. Another group (5.6 per cent) was that in which there was a hearing gain after the operation, but this gain was lost over a variable period to within 10 deci-

TABLE 1.—*Distribution of 384 Cases According to Age at Time of Operation* *

| Age, Yr. | Number of Cases | Per Cent |
|---|---|---|
| 10 to 19 | 4 | 1.0 |
| 20 to 29 | 71 | 18.5 |
| 30 to 39 | 151 | 39.3 |
| 40 to 49 | 100 | 26.0 |
| 50 to 59 | 51 | 13.2 |
| 60 to 69 | 6 | 1.5 |
| 70 up | 1 | 0.26 |
| Total | 384 | 99.76 |

* Six of the 390 records did not indicate the age of the patient.

TABLE 2.—*Distribution of Cases According to Preoperative Suitability*

| Preoperative Classification | Number of Cases | Per Cent |
|---|---|---|
| A (ideal) | 229 | 58.7 |
| B | 120 | 30.7 |
| C (borderline) | 41 | 10.5 |
| Total | 390 | 99.9 |

TABLE 3.—*Distribution of Cases According to Long Term (Five to Ten Year) Hearing Results*

| Hearing Result | Number of Cases | Per Cent |
|---|---|---|
| Group 1<br>No significant improvement at any time | 22 | 5.6 |
| Group 2<br>Improvement lost (to within 10 decibels preoperative level) | 22 | 5.6 |
| Group 3<br>Gain partially lost | 73 | 18.7 |
| Group 4<br>Hearing improvement fully maintained (within 10 decibels of best test) | 273 | 70.0 |

bels of the preoperative level. In a third group (18.7 per cent) was shown a partial loss of the initial gain, and in the largest group (70 per cent) was shown a good initial gain, which was maintained for as long as the case has been followed. Table 3 shows the distribution according to the long term hearing result.

With regard to the possible influence of the age of the patient on the long term result, it may be of some importance to observe that only 50 per cent of the four patients operated on under the age of 20 obtained a hearing gain that was

2. Shambaugh, G. E., Jr.: Fenestration Operation for Otosclerosis: Experimental Investigations and Clinical Observations in 2100 Operations Over a Period of 10 Years, Acta otolaryng., 1949, supp. 79, p. 1.

fully maintained for five years or more (table 4). By contrast, 100 per cent of the seven patients operated on past the age of 60 obtained a hearing gain that was fully maintained for this long period. It must be admitted that these small groups may not be statistically significant, and the conjecture that the bone of the labyrinthine capsule reacts most vigorously to the trauma of operation in a patient less than 20 years and least vigorously in a patient more than 60 years must be regarded as only a suggestion until the condition in larger groups of patients has been studied for a sufficient period. The observation that poorer results are obtained in the younger age group has, however, been made elsewhere.[3]

For purposes of comparing the results obtained during the early with those of the later years of the period in this series, the 390 cases were grouped by those in which the operation was made in the first three years and those in which it was made in the last two years. During the period from July 1940 to July 1943, the continuous irrigation and operating microscope for producing a bone dust-free fenestra were in use, and some innovations, such as the fenestra nov-ovalis,[4] were added. Several further changes in technic were instituted during the time between July 1943 and July 1945, such as wide enchondralization, doming of the fenestral

TABLE 4.—*Correlation of Age and Hearing Result in 384 Cases* *

| | Group 1 No Gain | | Group 2 Gain Lost | | Group 3 Gain Partly Lost | | Group 4 Gain Maintained | |
|---|---|---|---|---|---|---|---|---|
| Age, Yr. | Number | Per Cent | Number | Per Cent | Number | Per Cent | Number | Per Cent |
| 10 to 19..... | 0 | 0 | 1 | 25 | 1 | 25.0 | 2 | 50 |
| 20 to 29..... | 9 | 12.9 | 2 | 2.8 | 9 | 12.6 | 50 | 70.4 |
| 30 to 39..... | 6 | 3.9 | 9 | 5.9 | 33 | 21.8 | 101 | 66.9 |
| 40 to 49..... | 4 | 4 | 6 | 6 | 20 | 20 | 69 | 69 |
| 50 to 59..... | 3 | 5.9 | 3 | 5.9 | 10 | 19.9 | 36 | 69.2 |
| 60 to 69..... | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 100 |
| 70 up..... | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100 |
| Total..... | 22 | .. | 21 | .. | 73 | .. | 268 | .. |

* Six of the total number of cases could not be considered in age tables.

Together with the number of patients in each result group from the various age periods is included the per cent of the total number in that age period. Thus it can be seen that 100 per cent of the patients operated on aged 60 years or more obtained a good result and maintained it. Only 50 per cent of those under the age of 20 years obtained a good result that was maintained. This result may indicate a diminishing reaction of the bone of the labyrinthine capsule to trauma with advancing age.

site and, finally, endosteum hemming of the fenestra, all of which resulted from experimental studies on animals [5] and which, together, constitute the "improved Northwestern University technic." There were 239 fenestrations done during the first three years and 151 during the last two years.

The cases in each of the four result groups were further studied to throw some light on the possible or probable reasons for the failure of treatment (groups 1 and 2) and the partial failure (group 3).

## RESULTS OF FENESTRATION

*Group 1; No Gain.*—Postoperative serous labyrinthitis has long since replaced osteogenic closure of the fenestra as the principal cause of complete failure in

3. Walsh, T. E.: Personal communication to the author.

4. Lempert, J.: Fenestra Nov-ovalis: A New Oval Window for the Improvement of Hearing in Cases of Otosclerosis, Arch. Otolaryng. **34**:880 (Nov.) 1941.

5. Shambaugh, G. E. Jr., and Juers, A. L.: Surgical Treatment of Otosclerosis: A Preliminary Report on an Improved Fenestration Technic, Arch. Otolaryng. **43**:549 (June) 1946.

fenestration operations at Northwestern University.[2] There were 22 patients in this very interesting group in which treatment resulted in failure. They either failed to gain appreciably or actually lost in hearing acuity immediately after the operation. An appreciable or significant gain was considered to be an increase of 10 decibels or more in the average of the three critical speech frequencies. In an attempt to explain the failure, the records of these 22 patients were reviewed carefully. The fenestrations were about equally divided between the two time periods, 10 having been done during the first three years and 12 during the last two years. When the operative notes were examined, it was noted that in 12 cases, or 54.5 per cent, bleeding was mentioned as having been bothersome or more than average during the operation. To check further into the possible importance of this high incidence of bleeding as a complication of the operation, the 100 consecutive cases following the series of 390 fenestrations were studied for mention of bleeding in the operative notes. In this 100 unselected consecutive cases following the series, in only 18 was there any mention at all of bleeding in the operative note. This observation confirmed the view previously expressed [2] that excessive bleeding is very important as a cause of postoperative serous labyrinthitis.

The sex incidence in this group in which there was no hearing gain was about equal. There were 10 male and 12 female patients, as compared with 97 male and 293 female patients in the entire series of 390 operations. This incidence bears out the clinical impression that men tend to bleed more during the fenestration operation than women.

Two other interesting points were noted about this group. In almost all the cases, studies were made of the postoperative bone conduction, and in 13 of them the bone conduction remained about as it was before the operation. In the cases in which the air conduction remained about the same also, one might have expected no change in the bone conduction audiogram. However, it was noted in one or two cases that the air conduction level was made worse by the operation, whereas the bone conduction remained the same. There is no satisfactory explanation at this time for such a discrepancy.

The other interesting observation was with regard to the fistula reaction in these cases. In two, no mention is made of fistula reaction postoperatively, but in 18 of the remaining 20 the fistula reaction was positive after the operation. In one case there was a positive fistula reaction before but not after a revision; in another there was a positive reaction on the first postoperative day elicited by pressure on the outer dressing, and it was negative on the second day after an attack of spontaneous vertigo. The persistence of a strongly positive fistula reaction, even in the presence of cochlear damage, points up the already known fact that the canalicular end of the inner ear is functionally more sturdy and phylogenetically more primitive than the cochlear end.

*Group 2; Improvement Lost—Bony Closure.*—When a patient received a good hearing improvement soon after the fenestration and then lost it months or years later, so that his hearing returned to within 10 decibels of the preoperative level, he was presumed to have had a bony closure of the fenestra until proved otherwise at revision.

Although the early history of fenestration surgery is an account of attempts to overcome osteogenic closure of the artificially produced opening into the peri-

lymphatic space,[6] bony closure of the fenestra to sound is becoming of secondary importance at Northwestern University in accounting for possible causes of complete failure. Thus of the 22 probable closures (group 2), 21 occurred in the patients who were operated on during the first three years of the period and only 1 in the patients operated on during the last two years (table 5).

The records in 19 of the cases of probable closure were complete enough to allow estimation within reasonable limits of when the bony closure took place. The average time was 8.6 months; the shortest time was 8 weeks, and the longest time was 39 months. These periods are the time that it took for the average level at the three critical speech frequencies to return to within 10 decibels of the preoperative level. The condition in the case in which 39 months was required for the return to the preoperative level was proved by revision to be a bony closure, and

TABLE 5.—*Correlation of Date of Operation with Hearing Result* *

| | Group 1 No Gain | Group 2 Gain Lost | Group 3 Gain Partly Lost | Group 4 Gain Maintained |
|---|---|---|---|---|
| Number of patients operated on between July 1940 and July 1943..... | 10 | 21 | 46 | 166 |
| Number operated on between July 1943 and July 1945..... | 12 | 1 | 27 | 107 |
| Total ..... | 22 | 22 | 73 | 273 |
| Per cent..... | (5.8) | (5.8) | (18.4) | (70) |

* Of the 390 patients, 239 were operated on during the first three years of the series, 151 during the last two years.

TABLE 6.—*Distribution of Cases According to Result and Preoperative Classification*

| Results | A | B | C |
|---|---|---|---|
| No gain..... | 11 | 8 | 3 |
| Probable bony closure..... | 5 | 13 | 4 |
| Partial loss of gain..... | 43 | 22 | 12 |
| Gain fully maintained..... | 170 | 77 | 22 |
| Total..... | 229 | 120 | 41 |

the patient regained an adequate hearing level, which has been maintained until the present time.

More than half (12) of these probable closures were positively proved by revision. In three of the revisions, no mention is made in the operative note of the site of the osteogenesis. In nine, however, it was noted from which of the layers of the labyrinthine capsule arose the bone closing the fenestra. Six of the closures were caused by bone arising from the endosteal layer and three by periosteal osteogenesis. The periosteal layer being the most active of the three layers of the capsule, the small number of closures attributable to that layer is no doubt due to the technic of wide enchondralization of the fenestral site.[5]

*Group 3; Partial Loss of Gain.*—In slightly less than 20 per cent of the patients (table 5) there was an initial significant gain, a part of which was subsequently lost. There were 73 patients in this group. Some of them had the loss chiefly

6. Lempert, J.: Improvement of Hearing in Cases of Otosclerosis: A New One Stage Surgical Technic, Arch. Otolaryng. **28**:112 (July) 1938.

in the higher frequencies of the audiometric range, some in the lower frequencies and some chiefly in the middle tones or all tones.

Thirty of these 73 (40.6 per cent) were considered to have had the partial loss of gain because of increased cochlear nerve degeneration, as evidenced by high tone loss at air conduction audiometry, or by bone conduction when available. Unfortunately, bone conduction tests were not made postoperatively in many of these cases, and a drop in the hearing acuity at 2048 cycles per second by air conduction was considered to be indicative of an increase in cochlear nerve degeneration when there was not a corresponding decrease for the lower tones. It is fully realized that this line of reasoning is subject to criticism, since a loss for the

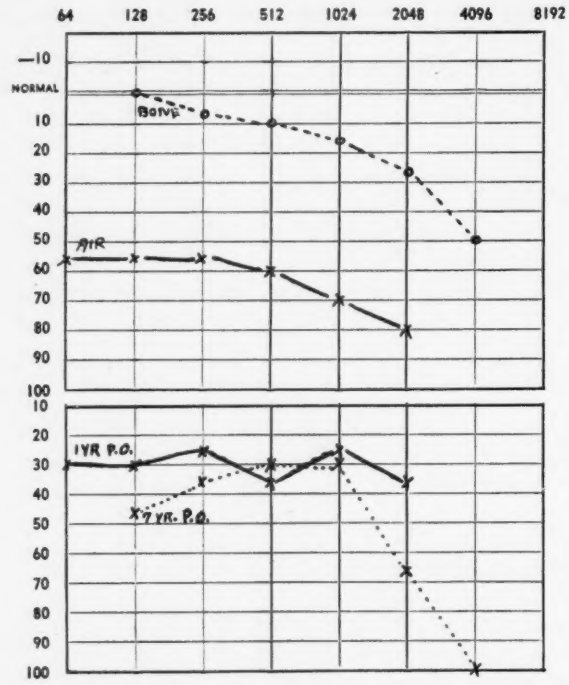


Chart 1.—Preoperative (right ear) and postoperative (air conduction) audiograms of a patient with partial loss of gain due to a drop chiefly in the high tones. It is presumed that such a drop was due to increased cochlear nerve degeneration. Of the 390 patients observed for five to 10 years, 7.7 per cent lost part of their gain in this manner.

high tones in air conduction is not always accompanied with an equivalent amount of loss by bone conduction. However, the relative inadequacy of the early audiometry for bone conduction, with regard to control and calibration, may make this criticism less severe. Lacking any better explanation at this time, we have considered this type of partial loss after fenestration to be due to changes in the cochlear nerve. Chart 1 shows the audiograms in such a case, demonstrating a considerable loss at 2048 cycles per second (30 decibels) while the other two important speech frequencies remain approximately the same.

The average level for this group of 30 patients with a high tone loss one year after operation was 37.9 decibels, with an average gain due to the fenestration operation of 22.9 decibels for the critical speech frequencies. At the last test, five to 10 years after the operation, the average level was 46.4 decibels, representing an average gain of 14.4 decibels. In six, the 2049 cycles per second drop occurred only in the ear operated on. This fact will be referred to when the possible effect of the fenestration operation on progressive cochlear nerve degeneration is considered later. In 12 the drop occurred in both ears, and in the remaining 12 the opposite ear had been fenestrated within a five year period.

Six patients lost part of the hearing gain because of a drop primarily in the low frequencies of the audiometer. Chart 2 shows the audiograms in such a case. It is thought that this type of partial loss is probably due to partial bony closure

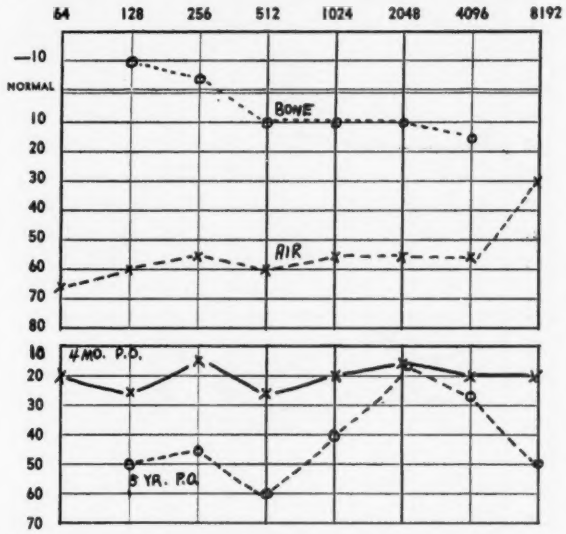


Chart 2.—Preoperative and postoperative audiograms (right ear) of a patient with partial loss of gain due to a drop in low tones. This is an example of the audiogram in a case of probable partial bony closure. Of the 390 patients, 1.5 per cent lost part of their gain in this manner.

of the fenestra, though in one instance at revision there was found a widely patent fenestra with soft gelatinous fibrous tissue filling the perilymphatic space. In all these six patients closure occurred during the last two years of the series, so if the bony closures are partial, perhaps the improvements in technic have made it impossible for the bone to provide enough osteogenesis to close the fenestra completely. The average level at one year in this group was 32.5 decibels, and at the last test, five to ten years postoperatively, the average level was 43.0 decibels.

Thirty-seven patients with a partial loss of gain showed decreased acuity for all frequencies (chart 3). The average loss in the speech frequencies was 11 decibels, but in no case did the loss return the patient to within 10 decibels of his preoperative level. In most of the cases the loss was gradual and became apparent

only when audiograms taken some time apart were compared. As a rule, the loss began a year or more after the operation, but in one case the loss did not become evident until the sixth postoperative year. Nineteen of the 37 patients were operated on during first three years of the series and 18 during the last two years.

When the records of this group were reviewed in an attempt to find a possible clue to the cause of the loss, no explanation could be given for 14. Eleven patients showed definite fluctuations in hearing from time to time, along with variable inner ear disturbances, such as vertigo, and a sensation of fulness in the ear operated on.

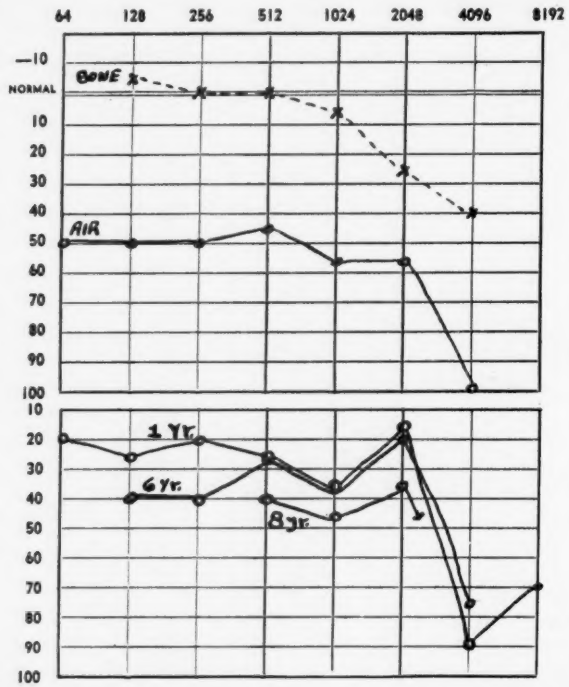


Chart 3.—Preoperative (left ear) and postoperative (air conduction) audiograms of a patient in whom partial loss of gain occurred six years postoperatively. No satisfactory explanation could be offered for the loss.

It seems possible that the partial loss in these 11 was due to hydropic phenomena with intermittent depression of the cochlear end organ. These postoperative inner ear symptoms occurred frequently enough in the series as a whole to attract attention. The definite triad of hearing fluctuation, vertigo and a sensation of fulness was complained of by 10 per cent (38 patients) of those observed. This number does not include an even larger number of patients who complained of transient inner ear disturbances or of only one or two of the symptoms. There was no orderly arrangement of the symptoms or of the patients complaining of them with regard to time of operation, hearing result, preoperative classification, time of onset

after operation or age. The triad has been described,[7] as has its treatment with histamine. In this group of 37, there were 20 who received low dosage histamine therapy, 12 with good and 8 with equivocal results. From the very intermittency of the complaints, any evaluation of treatment must be guarded.

Nine of the patients with a partial loss of gain in all frequencies showed the loss to be more pronounced in the middle tones of the audiometer (chart 4). Some of them showed a bone conduction dip at the same frequencies preoperatively, and this middle tone dip has been seen frequently enough to suggest that such a speech frequency dip may be characteristic in certain cases of otosclerosis. From a purely conjectural standpoint, one might attempt to explain this middle tone drop by

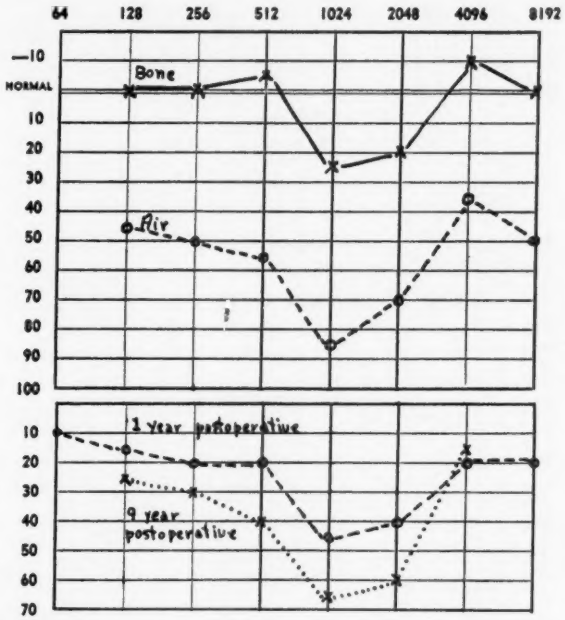


Chart 4.—Preoperative and postoperative audiograms (right ear) of a patient with partial loss of gain with a marked middle tone dip, before and after operation.

using the theory of Siebenmann on the basis of the encroachment of an otosclerotic focus on the portion of the cochlea housing the part of the basilar membrane, which is selectively receptive to the sounds of the middle frequencies, and the diffusion at this point of toxic metabolites into the labyrinthine fluids.

The usual object of fenestration surgery being to bring the deafened patient into unaided social adequacy, it was decided to group all the patients who had lost a part of their initial gain into three classes of rehabilitation [2] to determine how successful the operation had been five to ten years later despite the partial loss.

7. Shambaugh, G. E., Jr.: Histamine in Treatment of Certain Types of Headache and Vertigo Following the Fenestration Operation, Arch. Otolaryng. **51**:781 (June) 1950.

TABLE 7.—*Number of Cases in Each Rehabilitation Status at One Year and Last Test from Group 3, with Partial Loss of Gain (73 Cases*)*

| | Complete Rehabilitation | | Partial Rehabilitation | | No Rehabilitation | |
|---|---|---|---|---|---|---|
| | One Year | Last Test | One Year | Last Test | One Year | Last Test |
| High tone loss, 25 cases | 11 | 2 | 7 | 7 | 11 | 20 |
| Low tone loss, 6 cases | 2 | 0 | 2 | 2 | 2 | 4 |
| All frequency loss, 37 cases | 18 | 3 | 14 | 13 | 5 | 21 |
| Total | 31 | 5 | 23 | 22 | 18 | 45 |
| Per cent | (42.4) | (6.8) | (31.5) | (30.1) | (24.6) | (61.6) |

* One case with high tone loss was omitted as the one year audiogram was not available.

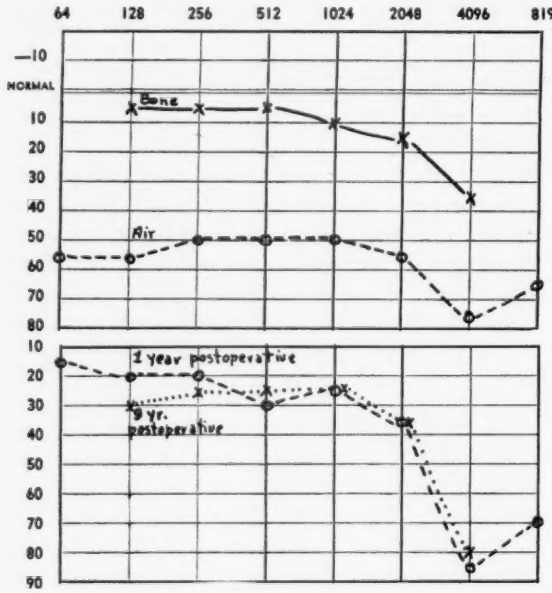


Chart 5.—Preoperative and postoperative audiograms (right ear) of a patient who has maintained a good hearing level for nine years. Of the 390 patients with fenestration observed from five to 10 years, 70 per cent maintained a good gain completely.

A patient was considered to be completely rehabilitated if the hearing level arrived at by averaging the decibel loss at the three critical speech frequencies was 30 decibels or less. If the level was 31 to 40 decibels inclusive, the patient was considered to be partially rehabilitated, and if the level was 41 decibels or lower the patient was not considered rehabilitated no matter how much gain he might have received from the operation. Table 7 depicts the distribution of the patients in these three groups, at both one year after operation and at last test. Needless to say, the fact that a patient is not rehabilitated does not always mean that he has not received some benefit from the operation.

*Group 4; Good Gain Maintained.*—There were 273 patients, 70 per cent of the total number, who received an initial significant gain and maintained that gain for

five years or longer. Chart 5 shows the audiograms in such a case in which the nine year postoperative level is the same as the one year level. As in the other groups, a significant gain means 10 decibels or more in the average of the critical speech frequencies. In this group of 273, however, only seven received a gain which was less than 15 decibels. This rate means that 266 patients had a maintained hearing gain of 15 decibels or more.

Tables 8 and 9 show the rehabilitation status of these 273 patients at the last hearing test. The average decibel level at one year after the fenestration operation

TABLE 8.—*Rehabilitation Status at Last Test of 273 with Full Maintenance of a Significant Gain for Five to Ten Years*

| Classification | Number | Per Cent |
|---|---|---|
| Complete rehabilitation | 107 | 41.0 |
| Partial rehabilitation | 88 | 31.8 |
| No rehabilitation | 74 | 26.8 |

TABLE 9.—*Correlation of Preoperative Classification and Rehabilitation Status at One Year After the Fenestration Operation in 273 Cases (Group 4) with Maintenance a Significant Gain* *

| Classification | A | B | C |
|---|---|---|---|
| Complete rehabilitation | 101 (59%) | 12 (15.2%) | 0 |
| Partial rehabilitation | 51 (29.8%) | 36 (45.5%) | 2 (8.7%) |
| No rehabilitation | 19 (11.1%) | 31 (39.2%) | 21 (91.3%) |
| Total | 171 | 79 | 23 |

* Note that of the 171 ideal subjects for the fenestration operation who maintained their hearing gain, 59 per cent were completely rehabilitated at the end of the first year; 30 per cent were partially rehabilitated, with the hearing level at 40 decibels or better, while only 11 per cent were not rehabilitated.

TABLE 10.—*Average Decibel Gains and Levels for All Patients Except Those with Probable Bony Closures and Those with No Gain at All After Fenestration*

| | Fenestrations Done Between 7/1/40 and 7/1/43 | | Fenestration Done Between 7/1/43 and 7/1/45 | |
|---|---|---|---|---|
| | At One Year | At Last Test | At One Year | At Last Test |
| Average decibel gain | 25.0 | 22.9 | 28.9 | 25.6 |
| Average decibel level | 35.6 | 38.0 | 32.4 | 35.5 |

in this group was 34.0 decibels, and at the last test it was 34.5 decibels. There were 160 fenestrations done during the first three years of the series and 109 during the last two years. Included in the group were four patients who had persistent perforations of the tympanic membrane postoperatively but who had good hearing levels as long as the perforations were covered with thin paper patches.

Considering the over-all picture of hearing after the fenestration operation, it becomes evident that for the patients observed for five years, with the exception of those who never get a good result immediately following the operation and those with a probable bony closure, the outlook is not discouraging. Table 10 shows the decibel gains and levels of this group of 346, at one year and at the last test, on the basis of fenestrations done during the first three and last two years of the series.

### INFLUENCE OF PREGNANCY

In the series there were 18 patients who became pregnant after their fenestration, three of them becoming pregnant twice. It has been stated repeatedly that pregnancy and lactation have a deleterious effect on the hearing in otosclerotic women. Recently among a large group of patients, it was observed that pregnancy had an accelerating effect on the hearing loss in about one out of four.[8] In this group of 18 women there was only one who gave any objective evidence of increased hearing loss in the fenestrated ear during or following pregnancy after the fenestration operation. This patient noted a drop in her hearing substantiated by audiometry after the second pregnancy after her operation, which would seem to lend some support to the assertion[9] that the likelihood of hearing impairment due to pregnancy increases with each pregnancy in otosclerotic women. One other patient experienced a subjective hearing loss during pregnancy, not substantiated by audiometry, which cleared up after delivery. Another patient experienced an increase in tinnitus during gestation. Of the opposite ears in these 18 women, six were fenestrated within a five year period. Thirteen showed no increased hearing loss, and two showed moderate progressive nerve degeneration. The present conservative attitude toward the interruption or proscription of pregnancy in otosclerotic women[10] seems to be confirmed by this study.

### EFFECT OF FENESTRATION ON THE PROGRESSIVE NATURE OF OTOSCLEROSIS

In an attempt to throw some light on the possible influence of fenestration on the progressive hearing loss of otosclerosis, particular attention was directed toward any evidence of further cochlear nerve damage in the ears not operated on in this series. In 149 patients the opposite ear was fenestrated within a five year period, leaving 241 for whom follow-up observations for five years or more could be made on the ear not operated on.

Of these 241 patients, 176, or 73 per cent, showed no increase in cochlear nerve degeneration in the ear not operated on after a five year period. Nineteen, or 7.8 per cent, showed some increase in cochlear nerve degeneration along with that of the ear operated on. Forty-six, or 19 per cent, showed increased cochlear nerve degeneration with no corresponding loss in the ear operated on, while there were only six, or 2.5 per cent, in the total series who showed cochlear nerve degeneration only in the ear operated on. The impression has been previously expressed[11] that an ear is provided some measure of protection against future cochlear nerve degeneration by the fenestration operation, but no one has had a sufficiently large series with studies made on the ear not operated on to come to any definite conclusions. In the present study of 390 patients—observed for five

8. Shambaugh, G. E., Jr.: Chapter on Otosclerosis, in Coates, G. M.: Cyclopedia of Otolaryngology, to be published.

9. Zangemeister, H. E., and Schmidt, B.: Zur Schwangerschaftsunterbrechung wegen Otosklerose, Deutsche med. Wchnschr. **70**:113 (March 3) 1944.

10. Allen, E. D.: Pregnancy and Otosclerosis, Am. J. Obst. & Gynec. **49**:32 (Jan.) 1945. Barton, R. T.: The Influence of Pregnancy on Otosclerosis, New England J. Med. **233**:433 (Oct.) 1945.

11. House, H. P.: What Can Be Done for the Deafened Today? California & West. Med. **63**:130 (Sept.) 1945. Shambaugh, G. E., Jr.: Effect of Fenestration Operation on Nerve Degeneration of Otosclerosis, Tr. Am. Acad. Ophth. 1949, Nov.-Dec., supp., p. 42.

to 10 years, progressive nerve degeneration occurred eight times more frequently in otosclerotic ears that had not been fenestrated than in those that had been.

It should be mentioned that on theoretical grounds one should not expect the fenestration operation, which merely by-passes the otosclerotic obstruction at the oval window, to have any effect whatsoever on the progressive nature of the pathologic process of the bone or on the progressive cochlear nerve degeneration that so frequently results from this change. The fact that in this rather large series of carefully studied cases the fenestration did appear to protect the ear operated on as compared to the ear not operated on is incontrovertible. The explanation of this fact remains unknown.

With regard to the idea that there may be a hearing improvement in the ear not operated on following fenestration, the hearing gain or loss of all the 390 fenestrated ears was studied. At the last test, five to 10 years postoperatively, 128 fenestrated ears had lost an average of 6.7 decibels and 90 had gained an average of 4.4 decibels. The remainder were unchanged or were fenestrated within the five year period. Of the total, 32 per cent lost and 23 per cent gained, but the average loss or gain was so small that it cannot be considered significant. It would seem from this study that the ear not operated on is not affected by the operation, as indeed would be expected.

## SUMMARY AND CONCLUSIONS

In a series of 390 fenestration operations with five to 10 years' follow-up observation, 70 per cent of the patients received a significant hearing improvement and have maintained it.

The remaining 30 per cent are divided roughly into 20 per cent who lost a part of their initial gain but who may still have a usable level of hearing, 5 per cent who had no hearing improvement at all and 5 per cent who were considered to have probable bony closures.

Attention is directed to the paucity of probable bony closures occurring during the last two years of the five year period (0.6 per cent) when most of the features of the "improved Northwestern University technic" were being employed.

Symptoms of inner ear disturbances, suggesting labyrinthine hydrops, were noted in more than 10 per cent of the patients postoperatively.

Pregnancy following the fenestration operation does not seem to result in further cochlear nerve damage.

Progressive postoperative cochlear nerve degeneration was noted considerably more frequently in ears not operated on than in ears operated on. The fenestration operation thus affords at least partial protection to an ear against future cochlear nerve degeneration. The mechanism of this protection is not known.

# PHYSIOLOGICAL PRINCIPLES IN RHINOPLASTY

SAMUEL FOMON, M.D.
NEW YORK
WILLIAM Y. SAYAD, M.D.
WEST PALM BEACH, FLA.
ALFRED SCHATTNER, M.D.
AND
HARRY NEIVERT, M.D.
NEW YORK

NO SURGEON can do a considerable number of rhinoplastic operations without becoming aware, as in other branches of surgery, that a knowledge of physiology is essential. Certainly it is just as important that one acquaint oneself with the dynamics of nasal respiration as it is that one know the anatomy of the region and the pathological conditions that may be encountered there.

Our attempt to correlate nasal physiology with rhinoplastic surgery has brought us by devious byways to a point where today a clearer understanding of the problem is in the making. It has given us new and valuable concepts which, although far from satisfactory, more nearly meet our clinical needs. While we realize that planned experiments are essential to the solution of any problem, we also know that, nevertheless, clinical experience is a necessary preliminary to scientific investigation. The elaboration of our concepts forms the basis of this paper, which we hope will be found sufficiently provocative to induce further research.

A study of the nose as an isolated organ is arbitrary and unsatisfactory, since it imparts but a fragmentary and imperfect idea of its function. Only when the nose is envisioned as a link in the chain of tissue ventilation can a true concept of its physiology be attained.

Perhaps we can best illustrate our subject by submitting some of the common questions which have confronted us.

1. Is the external nose merely an architectural hominid peculiarity, or has it evolved in response to a physiological need?

To find the answer, we consulted the comparative anatomist and the anthropologist, who are thoroughly familiar with the phylogenesis and ontogenesis of the human nose.[1] Phylogenetically, the original function of the nose was solely olfaction. It was considerably later that the respiratory function was added. The olfactory portion of the nose in the newborn, therefore, is almost complete.

1. Hooton, E. A.: Up from the Ape, New York, The Macmillan Company, 1931. Hrdlicka, A.: Physiological and Medical Observations Among Indians of Southwestern United States and Northern Mexico, Bulletin 34, Department of the Interior, Bureau of American Ethnology, 1908. Gregory, W. K.: Our Face from Fish to Man: A Portrait Gallery of Our Ancient Ancestors and Kinsfolk, Together with a Concise History of Our Best Features, New York, G. P. Putnam's Sons, 1929.

It is essential for olfaction that the medium to be tested come in contact with the sensory cells. In animals that carry the body in a horizontal position the entrance and exit to the nose are in a vertical plane, with the nares directed forward and upward[2] (fig. 1). Thus, the respiratory air comes in intimate contact with the olfactory elements, which are distributed over the entire surface of the mucosa. But in man, who, in assuming the upright posture, removed the olfactory

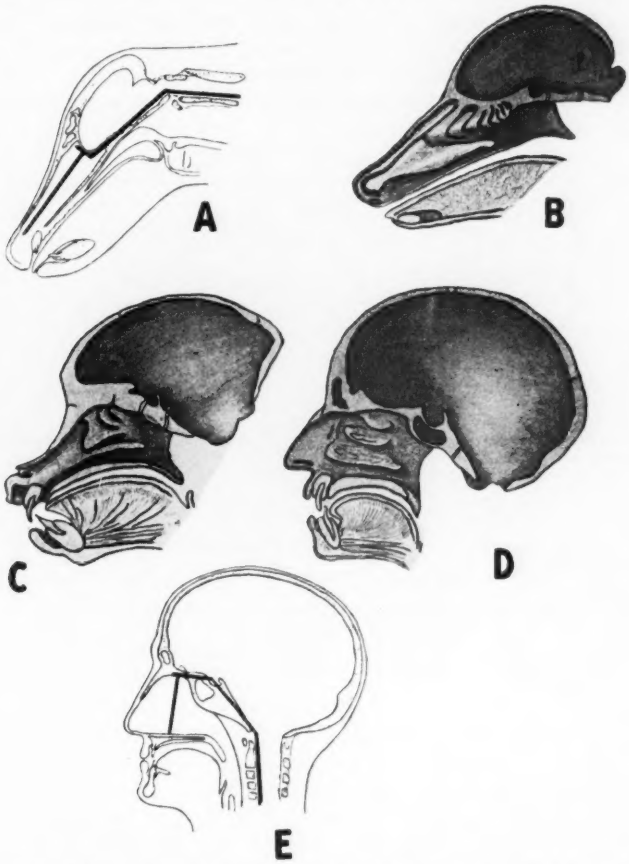


Fig. 1.—Plane of nasal entrance and exit in quadruped and man. *A*, dog; *B*, deer; *C*, baboon, and *D*, man. *E* is a diagrammatic representation of the nasal canal in man. From Böker[2b] and Bolk.[2a] For details, see text.

organ farther from the ground, the sense of smell lost considerable importance, and the olfactory area was consequently reduced to a surface of a few square

2. (*a*) Bolk, L.: The Problem of Anthropogenesis, Jena, Gustav Fischer, 1926. (*b*) Böker, H.: The External Nose as an Anatomic Structure, Ztschr. f. Morphol. u. Anthropol. **34**:47, 1934.

centimeters located in the upper portion of the olfactory sulcus. Had the nares continued to face in a forward direction, man would have lost the faculty of perceiving odors, for in these circumstances the arch of the respiratory air current would have been too low to reach the olfactory region (fig. 2). But in the process of evolution the nares assumed a dependent position as the result of a downward growth on the part of the nasal cartilages. This arrangement caused the current to arch upward to reach the olfactory area (fig. 3).

From a functional standpoint, the position of the nares is of great importance. This matter has been brought to our attention by patients who have reported improvement or—to our chagrin—impairment of breathing following operations about the nares. In seeking an explanation, we came to believe that irrespective of

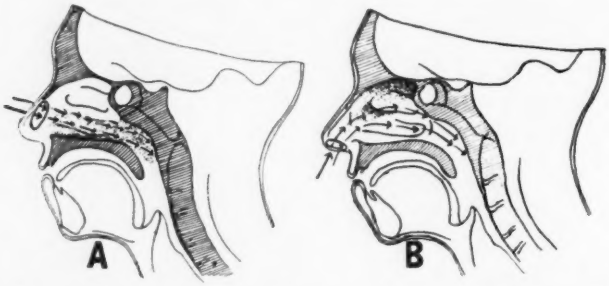


Fig. 2.—Sagittal section through human head. *A*, with nares facing forward, inspiratory current would course too low to reach olfactory area. *B*, with nares dependent, height of inspiratory air current is sufficient to stimulate olfactory cells. Modified after Böker.[2b]

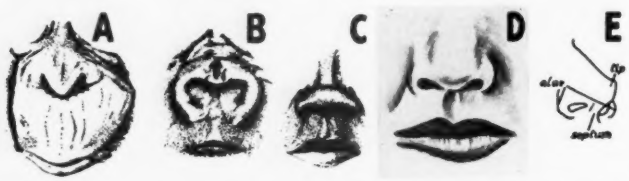


Fig. 3.—Downward growth of nasal cartilages, to place nares in a dependent position in order to raise arch of respiratory current. *A*, orang: lower lateral cartilages slightly developed; angles unite to form a groove. *B*, gorilla: cartilages well developed, forming ringlike swelling around nostrils; angles separated by furrow. *C*, primitive man: nose resembles that of newborn; cartilages tipped downward; lobules form thick bulb which overhangs septum; nostrils circular and visible from in front. *D*, modern man: cartilages extend farther downward; nares directed downward and concealed by lobule. *E*, diagrammatic representation of alar cartilages. Modified after Hooton.[1]

whether the angle between the nose and lip is right, acute or obtuse, there may be no interference with breathing provided that a normal relationship exists between the slope of the nares and the external nasal pyramid. But if, as a result of malformation, trauma or disease, the relationship between the slope of the nares and the external nasal pyramid is changed, impairment of function results, owing to misdirection of the current. For example, in the case of a tip made dependent by fracture or cicatricial contraction within the nose, the current is misdirected against the dorsum and shunted backward to form a whirl, which may prove as

obstructive as an anatomic fault [3] (fig. 4). The eddy playing on the mucosa causes a localized drying and a piling up and desiccation of the nasal mucus, which, by its irritation, results in inflammation, discomfort and pain. Bacteria flourishing in this favorable medium have a tendency to penetrate the mucosa. If, on the other hand, the nares have become unduly elevated, the arch of the current is flattened, and the air takes a more direct course (fig. 4). This, of course, also leads to drying, because it interferes with the precipitation of water on expiration and inhibits the development of both positive and negative pressures.

Through trial and error, we learned the value of preserving this relationship. For example, in the process of shortening the nose in a rhinoplasty which entails changing the slope of the nares from an acute angle to one of 90 degrees or more, impairment of function may result unless the external nasal pyramid is altered to conform to the new slope of the nares.

The size of the nares is also important to nasal function. Constriction of the opening may occur as the result of a dislocation of the mesial crura, thick alae, wide columella, thickening or buckling of the septum at the nasal inlet, spurs or ridges

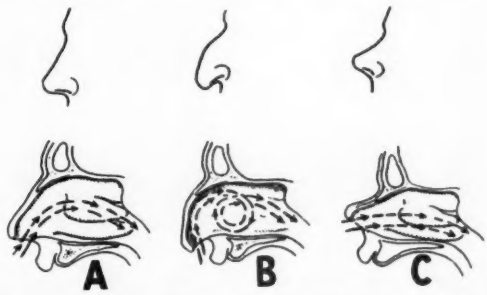


Fig. 4.—Inspiratory current. *A*, normal parabolic curve; *B*, impingement of inspiratory current on dorsum and formation of eddies in case of dependent tip, and *C*, flattening of arch and more direct course of current in case of unduly elevated nares.

on the floor of the nose, elongated, thickened or dislocated nasal spine or cicatricial contractions (fig. 5). Any of these faults may cause an increased negative pressure above the stenosis on inspiration, for the air cannot enter rapidly enough to equalize the pressures. This heightened negative pressure may be sufficient to cause collapse of the alae [4] and other disturbances, as discussed below.

The size and shape of the bony nasal pyramid also have a direct bearing on nasal physiology. Since ontogenesis follows the pattern of phylogenesis, the external nasal pyramid attains its ultimate shape relatively late. Even at birth it is still in a rudimentary stage, as in primitive peoples (fig. 3, *C*). Its growth keeps pace with the cultural *niveau* of the particular race. The prominence of the nose in man is not the result of an elevation of the framework above its surroundings but rather is due to a recession of the maxilla as man climbed up the evolutionary ladder. The transition from tree-dwelling climbers with prehensile extremities to

3. Fomon, S.; Silver, A. G.; Gilbert, J. G., and Syracuse, V. R.: Physiologic Surgery of the Nares, Arch. Otolaryng. **39**:608 (May) 1948.

4. Fomon, S.; Gilbert, J. G.; Caron, A. L., and Segal, S., Jr.: Collapsed Ala: Pathologic Physiology and Management, Arch. Otolaryng. **51**:465 (April) 1950.

biped walkers with hands free to manipulate tools brought about an impetus toward the development of the cerebral cortex. The resulting civilization wherein man uses his hands for the same purpose as a quadruped uses its jaws led to atrophy of the maxillary compound. The nose remained as the remnant of the animal face, just as an isolated mountain remains standing in a landscape that has been leveled by geologic processes. The changes that occurred to bring this about can be visualized if one takes a human silhouette and extends the outline of the nose in a suitable curve to come back under the chin. The resultant profile will show the original form [5] (fig. 6).

It is our clinical impression that the nose has been allotted a certain limited spatial content within each particular face, so that whatever one dimension possesses

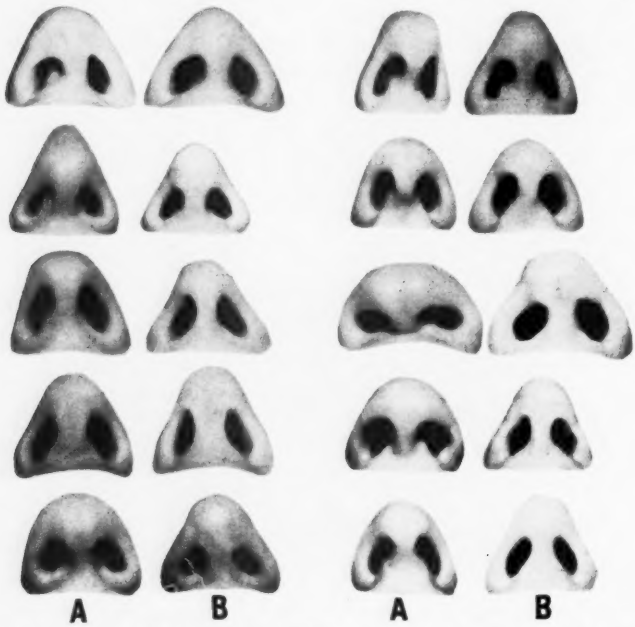


Fig. 5.—Types of nares interfering with function. *A*, constricted nares resulting in disturbance of function; *B*, restoration of function by reconstruction.

in excess must be subtracted from another. Thus, generally speaking, high elevated noses are narrow, and low flat noses broad.

The shape of the external nose is an index to the contour of the underlying cavity. It follows, then, that any pathological alteration in the shape or size of the external nose must necessarily disturb the course of the respiratory current and alter the intranasal pressures. The inspiratory current normally describes a parabolic curve [2b] (fig. 4), passing along a narrow channel beneath the dorsum. Since the nares lie at a somewhat lower level than the choanae, the current must

5. (*a*) Howell, W.: Mankind So Far, New York, Doubleday, Doran and Company, Inc., 1945. (*b*) Böker.[2b]

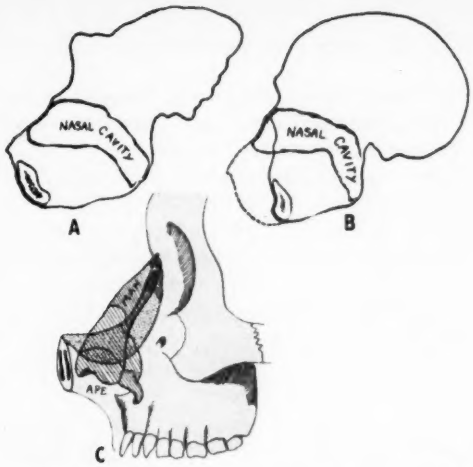


Fig. 6.—Sagittal section through skull of (*A*) gorilla and (*B*) man, showing nasal cavity. Note in *B* absence of protruding profile. Dotted line indicates parts which have undergone retrogression. *C*, superimposed heads of proboscis ape and man. From Böker [2b] and Howell.[5a]

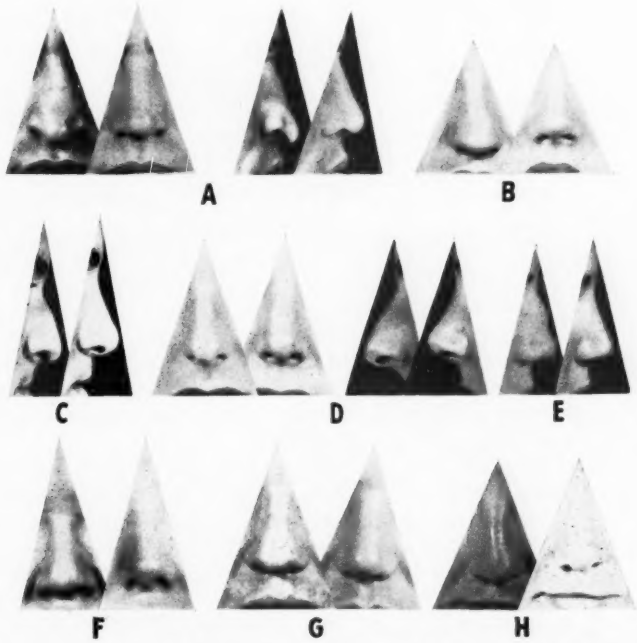


Fig. 7.—Examples of nasal deformities which interfere with function and their correction by plastic technic. *A*, deflection and fracture of septum and upper lateral cartilages, with faulty relationship between slope of nares and nasal pyramid, corrected by mobilizing and reassembling cartilages and shortening nose. *B*, cartilaginous deviation corrected by septoplasty. *C*, harelip nose corrected by plastic reconstruction of septum and repair of lip. *D*, thick septum corrected by excision of ventral border and shaving of septal walls. *E*, traumatic saddle nose corrected by excising hump and using it to fill depression above lobule. *F*, flat depressed tip corrected by modeling tip, supplemented by columella batten. *G*, old unreduced fracture of cartilages, corrected by mobilizing and readjusting cartilages. *H*, harelip nose with deflected septum, corrected by Fomon method of septal reconstruction.

necessarily arch from inlet to exit. A deflection, a hump or saddling of the nasal pyramid (fig. 7) may misdirect or obstruct the current. Function can be restored only by a plastic reconstruction. Here, we should like to recall a statement of Dr. George M. Coates [6] made in an address to the American Academy of Ophthalmology and Otolaryngology in regard to plastic surgery:

> The rhinologist through his training in and familiarity with nasal physiology and instrumentation definitely fits into the picture and with proper training is able to do excellent work in the field.

A similar opinion is expressed by MacKenzie Brown [7]:

> The rhinologist of tomorrow will find himself in a position in which he must practice reconstructive surgery of the nasal pyramid as well as of the internal nose and sinuses in order to restore normal nasal function to his patients.

According to Proetz [8] and Best and Taylor,[9] the caliber of the nasal canal, together with the action of the respiratory bellows (fig. 8), determines to a large extent the pressure differences between the atmospheric and intranasal air. As will be shown later, any factor which narrows the canal will accentuate the positive and negative pressures. Contrariwise, a widening of the canal will diminish the pressures. Too great a positive pressure will cause anemia of the membranes and, because of its obtunding influence on the mucosa, will interfere with the normal

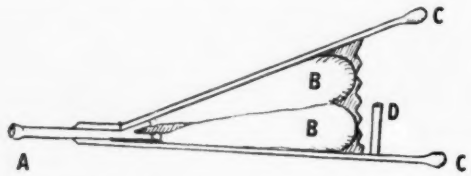


Fig. 8.—Diagram comparing a bellows to respiratory tract. *A*, nose; *B*, lungs; *C*, respiratory muscles operating bellows, and *D*, stop, to prevent complete closure of bellows. For details, see text (Best and Taylor [9]).

nasal functions. An increased negative pressure may result in traction on the membrane and lead to edema and extravasations. Too large a nasal passage—for instance, in atrophic rhinitis, saddle nose or after an unduly extensive submucous resection—by interfering with the development of optimal positive and negative pressures will cause nasal breathing to lose its superiority over oral breathing, as will be discussed in more detail later.

Alterations in intranasal pressures may also affect the ventilation of the paranasal sinuses and the middle ear, thereby resulting in the ill effects arising from an unduly great positive or negative pressure.[10] On inspiration, the negative pressure causes the air in the sinuses to expand. The volume of air in the sinuses becomes greater than the fixed capacity of the space, and air escapes. On expira-

6. Coates, G. M.: Two Problems: Care of Deafened and Rhinoplastic Surgery, Tr. Am. Acad. Ophth. **51**:11 (Sept.-Oct.) 1946.

7. Brown, J. M.: The Future of Otolaryngology, J. A. M. A. **135**:471 (Oct. 25) 1947.

8. Proetz, A. W.: Essays on the Applied Physiology of the Nose, St. Louis, Annals Pub. Co., 1941.

9. Best, C. H., and Taylor, N. B.: The Living Body: a Text in Human Physiology, New York, Henry Holt & Company, 1938.

10. Mink, P. J.: The Physiology of the Upper Respiratory Passages, Leipzig, F. C. W. Vogel, 1920.

tion, the rising pressure causes the air to become condensed, so that it fails to fill the sinuses, and, as a result, a relative vacuum is created (fig. 9).

The air pressures between the middle ear and the pharynx become equalized when the eustachian tube is opened during swallowing or yawning. Under negative pressure the air within the middle ear expands. When the differential pressure is increased to 3 to 5 mm. of mercury (110 to 180 foot [33 to 54 meters] altitude),[11] there is a sense of fulness in the ear, with a slight bulging of the tympanic membrane. When the differential reaches 15 mm. of mercury (500 foot [153 meters] altitude), the canal is forcibly opened as the tympanic membrane snaps back to its normal position. With a positive pressure the volume of air in the middle ear decreases. The eustachian tube remains closed regardless of the differential pressure in the middle ear, owing to the flutter valve action of the pharyngeal ostium, which permits air to escape but not to enter. This process may be accompanied with retraction of the drum, impaired hearing and tinnitus. Normally, the pharyngeal

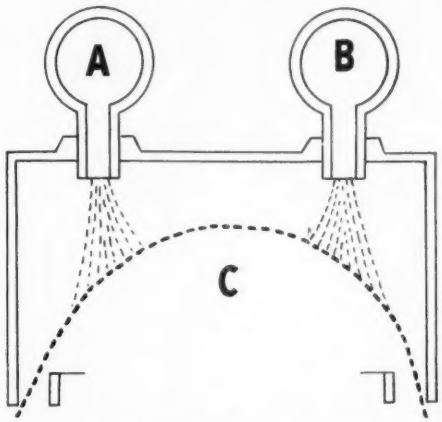


Fig. 9.—Diagram illustrating ventilation of sinuses. *A*, anterior group of sinuses; *B*, posterior group of sinuses, and *C*, nasal cavity. Negative pressure causes air in sinuses to expand; volume becomes greater than fixed capacity of space; air escapes.

pressures are such as to ventilate the ear properly, but in nasal obstructions the accentuated positive and negative pressures develop in the pharynx (as will be discussed later) may interfere with equalization of the air in the middle ear.

2. Why should one breathe through the long, narrow, indirect, tortuous tract of the nose, with its two right angle curves, when it is so much easier to obtain air through the more spacious and direct channel offered by the mouth? The usual answer is that nasal breathing provides for better warming, moistening and filtering of the air. One may ask the following questions: Are these the main functions of the nose, or have they been overemphasized to the neglect of other and perhaps more important functions? Furthermore, why is the nose so constructed as to

11. Armstrong, H. G.: Principles and Practice of Aviation Medicine, Baltimore, Williams & Wilkins Company, 1939.

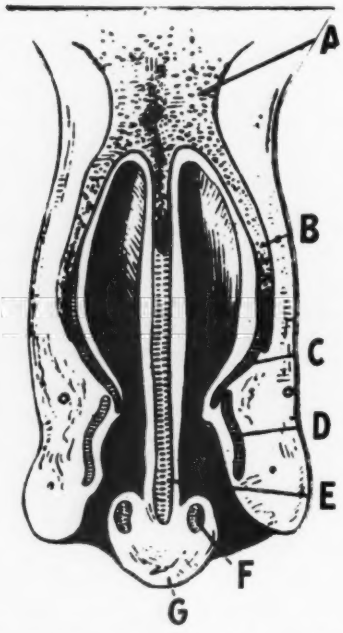


Fig. 10.—Coronal section through nasal pyramid. *A*, nasal bone; *B*, frontal process of maxilla; *C*, upper lateral cartilage; *D*, lower lateral cartilage; *E*, septum; *F*, mesial crus of lower lateral cartilage, and *G*, columella.

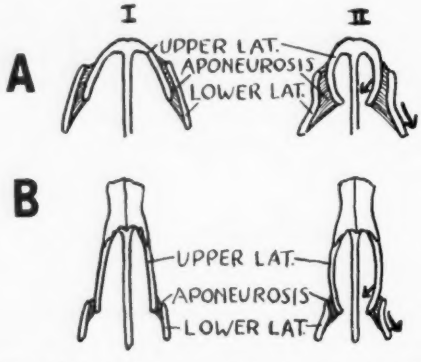


Fig. 11.—Nasal cartilages during quiet and deep inspiration. *I*, quiet inspiration: *A*, horizontal section; *B*, coronal section. *II*, deep inspiration: *A*, horizontal section; *B*, coronal section. Arrows indicate inward swinging of upper lateral cartilages and outward swinging of lower lateral cartilages. Intervening aponeuroses prevent abutment of upper lateral cartilages against septum.

act in the capacity of a check-valve, impeding the flow of gases both on inspiration and expiration?

In quiet breathing the narrowness of the canal offers resistance to the current (fig. 10). When the oxygen requirement is greater, as in exercise, the impediment to the flow of air is further increased by the swinging of the upper lateral cartilages toward the septum (a fact which can be demonstrated by looking in the mirror when one takes a deep breath).

In deepest inspiration the aperture may be narrowed to a very small chink. Complete closure and shutting off of the current is prevented, however, by the action of the alae, which flare outward and upward and exert a checkrein traction

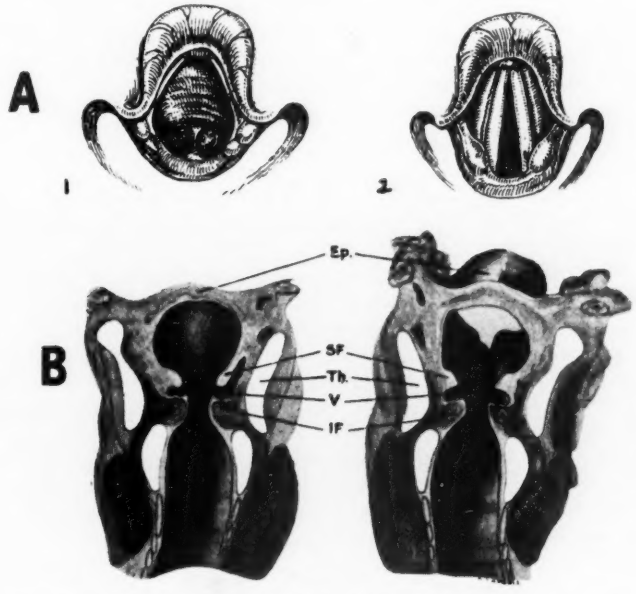


Fig. 12.—Position of vocal cords. *A*, horizontal view: *1*, inspiration; *2*, expiration. *B*, coronal section: *Ep.*, epiglottis; *IF*, inferior fold of vocal cord, acting as an inlet valve, and *SF*, superior fold of ventricular band, acting as an exit valve. From Mink [10] and Negus.[12]

on the connecting aponeurosis, thereby preventing the upper lateral cartilages from abutting the septum (fig. 11). As the inspired air continues backward in a descending curve, it finds itself cushioned on all sides by the erectile tissue of the conchae. The ability of this tissue to swell may further increase the impediment. On expiration the exit of air is likewise impeded by adduction of the vocal cords (fig. 12), the amplitude depending on the depth of the expiration. Negus [12] states:

> The vocal folds approach each other during expiration. At all times the glottis of man is a choked and obstructing point, its cross-sectional area being less than the trachea. . . .

12. Negus, V. E.: The Mechanism of the Larynx, St. Louis, C. V. Mosby Company, 1929.

Pressman [13] observes:

> The false cords . . . when approximated . . . present from the superior aspect an inverted dome-like configuration so that pressure from above can easily separate them . . . but that pressure from below not only fails to separate them but by their "jamming" effect forces them together even more tightly. Thus they can effectively trap air within the lung and increase the intrapulmonary pressure. The true vocal cords present from the mechanical viewpoint the opposite of this situation. Their dome-like concavity is on the inferior surface so that they are unable to withstand pressures from below but can effect great resistance to pressure from above.

Moreover, the position of the inferior concha is such as to retard the exit of the outgoing air. It can be seen that the erectile tissue may act like a twofold rheostat, offering resistance both to the entering and to the departing current, cooperating with the nasal valve on inspiration and with the glottis on expiration.

The following questions naturally arise: Why, on inspiration, when the body needs air, is its entrance retarded? And why, on expiration, when a rapid interchange of air is necessary, is the exit obstructed?

Before answering these questions, we shall review briefly the ventilatory, respiratory and circulatory phases of nasal respiration.

### VENTILATORY PHASE

The ventilatory phase concerns the mechanical interchange of gases between the lung and the environment. Physiologists [14] state that with the body at rest 7.5 liters of air per minute are required for tissue oxygenation. In exercise as much as 150 liters may be needed. It is essential that this volume of air be introduced in a given unit of time. If the air is delivered too rapidly, there will be hyperventilation, with a washing out of the acid carbon dioxide (acapnea), a resultant elevation in $p_H$ of the blood (alkalosis) and an increase in its oxygen saturation. Or, if the air is delivered too slowly, there will be hypoventilation, with retention of carbon dioxide (hypercapnea), a resultant fall in the $p_H$ of the blood (acidemia) and a decrease in its oxygen content (anoxemia). The nose, by acting as a living rheostat or carburetor, has much to do with regulating the amount of air entering the lung, and thus helps to avert the foregoing dangers. Obviously, the amount of air which enters the lung depends on the caliber of the nasal canal and the velocity of the current passing through the canal.

*A. Caliber of Nasal Canal.*—Obviously, more work on the part of the respiratory muscles is required if a given volume of air in the same unit of time is taken in through the narrow nasal canal than through the spacious, more direct oral route. In other words, the resistance offered by the nose puts a load on the respiratory muscles, which, in turn, must contract more forcibly and deepen the inspiration. And herein, we believe, lies one of the chief benefits to be derived from nasal breathing. So important is the resistance to proper respiration that even mouth-breathers subconsciously try to emulate the physiological nasal resist-

13. Pressman, J. J.: The Possibility of Increasing the Ceiling of Flyers by Utilizing Artificially the Principle of the Laryngeal Sphincter Mechanism, to be published.

14. Best, C. H., and Taylor, N. B.: The Physiologic Basis of Medical Practice, Baltimore. Williams & Wilkins Company, 1945. Howell, W. H.: A Textbook of Physiology, edited by J. F. Fulton, Philadelphia, W. B. Saunders Company, 1949. MacLeod, J. J. R.: MacLeod's Physiology in Modern Medicine, ed. 9, St. Louis, C. V. Mosby Company, 1941.

ance to the air current by narrowing the opening between the lips and teeth to a small chink and applying the tongue to the palate. On the same grounds, in the case of a deflected septum, hypertrophy of the conchae on the wide side may represent a compensatory attempt to increase the respiratory resistance. On the other hand, in conditions such as atrophic rhinitis or after an unduly extensive septal resection, the resistance to the current may have been so completely removed as to nullify the purpose of the operation.

It is interesting to note that, despite the shortness of the nasal canal as compared with the rest of the respiratory tract, it offers, according to Rohrer,[15] nearly 50 per cent of the total tubular resistance (i. e., roughness of wall, speed and specific resistant constants).

With the body at rest, the resistance offered by the nasal canal meets the respiratory need, and no extra accommodation is necessary. During exercise, however, when more air is required, the canal becomes further narrowed by the swinging in of the upper lateral cartilages (fig. 11). This narrowing of the canal when there is a need for the entrance of more air is understandable on the following grounds:

The resistance offered by the constricted orifice puts a greater load on the muscles of respiration, and they must contract more forcibly to overcome this resistance. The more powerful contraction results in a deeper inspiration. Since the need for oxygen varies with the effort, the load on the muscles must be flexible. The upper lateral cartilages serve this purpose to a large degree by their graded inward swing.

*B. Velocity.*—The second factor which controls the amount of air entering the lung in a unit of time is the velocity of the current. The velocity of the current is dependent on the difference between the pressure of the atmosphere and that within the thorax. The atmospheric pressure being practically constant, the differential must be created by the action of the respiratory muscles on the thoracic cage. The more powerful their contraction, the greater the elevation of the chest; the more pronounced the negative pressure, the greater the pressure differential between the atmosphere and the air within the lung. All these reactions make for a greater velocity.

The caliber of the nose and the velocity of the current are so coordinated that a given quantity of air passes into the lung in a given unit of time. In quiet inspiration the caliber of the canal is not materially diminished and the velocity is low (there being no pronounced difference in pressure between that of the atmosphere and that within the lung), so that 0.5 liter of air is admitted about every four seconds. In deep inspiration, as mentioned before, the canal is narrowed in proportion to the depth of the inspiration. On the other hand, the velocity is increased, for reasons given above, so that a liter or more of air will enter every 8 to 10 seconds.

This constancy of relationship between depth and duration of respiration makes possible a more economical utilization of the air. To illustrate: When more air is required, as in exercise, it can be obtained either (*a*) by a more rapid, shallow respiration or (*b*) by a less rapid, deeper respiration. In (*a*), assuming that the

15. Rohrer, R.: Current Resistance in the Human Respiratory Passages and the Effect of the Irregular Ramification of the Bronchial System on the Course of the Air in the Various Pulmonary Regions, Arch. f. d. ges. Physiol. **162**:225, 1915.

rapidity is increased even to 50 times per minute, the duration of each respiratory cycle must obviously be reduced accordingly. The quantity of air taken in at each inspiration is necessarily less. Suppose the amount of the inspired air to be 300 cc. The total intake, then, will be 50 by 300 cc., or 15,000 cc. With an intake of 300 cc., 150 cc. will go to fill the dead space (respiratory tube) and 150 cc. will become available to the alveoli. Thus, in a minute, there will be delivered to the alveoli 50 by 150 cc., or 7,500 cc.

In (*b*), wherein air is drawn in through a slower, deeper inspiration, there will be an increased amount of air taken in with each inspiratory effort. Assuming there is an intake of 1,500 cc. and only 10 respirations per minute, the total intake will be the same as before—15,000 cc. But since the dead space remains the same, irrespective of the type of breathing, with an intake of 1,500 cc., 150 cc. will still go to fill the dead space, and 1,350 cc. will become available to the alveoli. At the rate of 10 respirations per minute, the volume delivered to the lung will be 1,350 by 10 cc., or 13,500 cc.

From this observation it can be seen that while an equal amount of muscular effort is employed in bringing in the 15,000 cc. of air in the two cases, nearly 50 per cent of it is wasted in (*a*), for the availability of this air to the lung in a shallow respiration is only half as great as that in a deep respiration. This rate represents an extreme waste of energy, when one considers that the respiratory movements, even in normal breathing, are repeated about 1,000 times an hour. Armstrong [11] observed:

> During ascent to high altitude there is a point at which the breathing becomes altered. This varies in different individuals but has been noted as low as 4,000 feet. At first, only depth of breathing is increased, which is an effective means of increasing the oxygen in the lungs, since in shallow breathing very little fresh air gets past the dead air spaces. At about 12,000 feet altitude the increased depth in breathing amounts to between 20 and 100 per cent increase in lung ventilation. With further ascent there is a greater increase in depth of breathing, and at around 20,000 feet each inspiration may amount to 600 to 1,200 cc. of air. The rate of respiration changes very little at any altitude and even under extreme conditions seldom increases more than 5 breaths per minute.

From what has been said, one might be led to assume that nasal obstruction would result in an increase in the volume of air admitted per minute. But the reverse is true on the following grounds: Normally, inspiration takes place as a result of active muscular contraction, whereas expiration occurs passively through the force of gravity and the elastic recoil of the thorax and lungs. Thus, the inspiratory movement is superior in strength to the expiratory. Since the resistance to stenosis is more easily overcome by the inspiratory muscles than by the weaker expiratory forces, more air is inhaled than can be exhaled. This occurrence results in an increase in the residual air and a diminution of the supplemental and complemental air [16] (fig. 13). The vital capacity thus experiences a decrease.

Furthermore, the inspired air must mix over a larger residual volume. In this way the oxygen concentration in the alveoli is diminished and, consequently, the diffusion of the oxygen into the pulmonary vessels is impeded.

The nose regulates not only the amount of air entering per unit of time but also the rhythm of respiration. At the end of inspiration a stimulus passes up

16. Arnaud, J.; Tulou, P., and Mérigot, R.: Exploration of the Respiratory Function—Physiology, Method of Investigation, Indications and Results, Paris, Masson & Cie., 1947.

the vagus to instigate the commencement of expiration, and at the end of expiration another stimulus causes resumption of inspiration. This occurrence is known as the Hering-Breuer reflex. As stated above, the resistance offered to the respiratory current in nasal breathing will cause air to enter and leave the lung more slowly and evenly than in oral breathing. Accordingly, the impulse controlling alternate inspiration and expiration will be delayed, and the inspiratory phase will pass over without sharp differentiation and almost unnoticeably into the expiratory phase. When the nose is eliminated from participating in respiration, as in oral breathing, the rhythm is more rapid, at times jerky, and the respiratory pause is longer.

Since in nasal breathing the negative pressure at inspiration is equalized more slowly in the pulmonary cavity than in oral breathing, and since at expiration the air is expelled more gradually (i. e., the negative pressure swings over more slowly to a positive pressure), the period of time for the equalization between outer and inner air pressure, as said before, will be longer and will thus permit more time for diffusion of the gases.

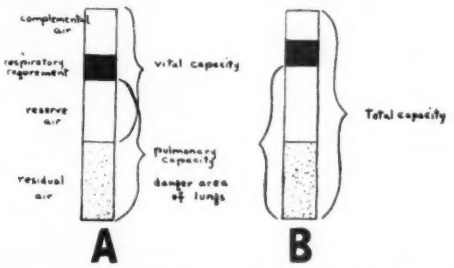


Fig. 13.—Diagrams showing increase in residual air and diminution of supplemental and complemental air in nasal obstruction. *A*, normal position of tidal air in vital capacity structure. *B*, position of tidal air in obstructed nasal respiration. From Arnaud, Tulou and Mérigot.[16] For details, see text.

An understanding of this physiology has had an important effect on our rhinoplastic surgery. Since the upper and lower lateral cartilages are so important from a physiological standpoint, we observe the greatest care in their modeling. We do not separate the upper lateral cartilages from the septum routinely as we did previously. In shortening the nose we sever the cartilages from the septum just far enough for the required reduction. To break the spring of the nasal bones, we introduce a chisel intranasally and puncture the junction between the nasal bones and upper lateral cartilages, to gain access to the osseous dorsum. We attempt to preserve the checkrein effect of the aponeurosis between the upper and lower lateral cartilages by making the initial incision just ventral to the upper lateral cartilages and transfixing with a no. 11 Bard Parker knife in place of the button-end knife.

### RESPIRATORY PHASE

Physiologists state that the interchange of gases between the alveoli and the blood is a physiochemical process of diffusion— i. e., an intermolecular mixing of gases of different densities, wherein the gases of higher concentration intermingle with those of lower concentration until they are equally distributed, with a con-

sequent equalization of pressure throughout. The rate of interchange is governed by their solubility, temperature, moisture, density and difference in pressure. Space will permit of the discussion of only the pressure factor.

To illustrate: When two communicating vessels are filled with volumes of air of different densities, the rapidity of equalization in pressure will be in direct proportion to the pressure difference between the two containers. It will, however, also be dependent on the diameter of the connecting piece; and, of course, the larger the opening of this connecting piece, the more rapid the equalization of pressures [17] (fig. 14). This example may be applied to the condition obtaining in respiration. In figure 14 one vessel represents the atmosphere; the connecting piece represents the mouth or nose, and the other vessel represents the pulmonary cavity.

The respiratory and circulatory systems in man are capable of adjusting themselves to varying degrees of pressure (up to an altitude of about 12,000 feet [3.6 kilometers]).[11] What mechanism makes this accommodation possible?

Air has weight, and, therefore, the layers of air near the earth's surface are pressed on by those above; thus, the higher the altitude, the less the pressure.

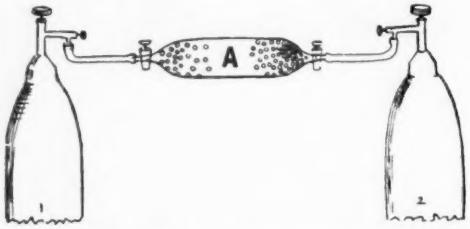


Fig. 14.—Diagram to illustrate diffusion of gases, with two gas cylinders containing gases of different pressures. In cylinder *1* gas pressure is lower than that in cylinder *2*. When samples of gas from each cylinder are allowed to enter glass chamber *A*, molecules intermingle, with consequent equalization of pressure throughout (Best and Taylor [9]).

According to Stevens,[18] the composition of atmospheric air remains practically constant up to a height of 72,000 feet. Diffusion depends more on the partial pressure of a gas than on its percentage in the air. Arnaud and associates [16] state:

> According to the "Law of Solution of Gases," . . . when a mixture of gases is exposed to a liquid, the amount of gas going into solution is proportional to the partial pressure of each of the gases. The alveolar air and the blood stream are, therefore, in equilibrium insofar as the partial pressure of oxygen in the alveoli is concerned. If the partial pressure of oxygen in the alveoli is increased, it necessarily follows that the oxygen content of the blood will increase in proportion.

To obtain the partial pressure of a gas, its percentage is multiplied by the barometric pressure. Thus, at sea level, the percentage of oxygen in the atmosphere being 20, the partial pressure will be $\frac{20}{100}$ by 760 mm. of mercury (barometric pressure at sea level), or 152 mm. of mercury. At an altitude of 18,000 feet (5.4 kilometers), the barometric pressure is 380 mm. of mercury, and the partial pres-

17. Werchowsky, B. W.: What is the Actual Advantage of Nasal as Compared with Oral Respiration? Reviewed in Zentralb. f. Hals-, Nasen- u. Ohrenh. **24**:412, 1935.

18. Stevens, A.: Man's Farthest Aloft, Nat. Geog. Mag. **69**:59, 1936.

sure of oxygen would be $\frac{20}{100}$ by 380, or 76 mm. of mercury. Such a pressure is insufficient to force adequate amounts of oxygen into the blood stream.

On inspiration, the chest enlarges, irrespective of the avenue by which the air enters. As mentioned before, if air can get in easily, as through the mouth or a tracheal opening, the pressures are low and quickly equalized. But when the air is admitted through the narrow nasal canal, the higher and more sustained negative pressures bring in a greater quantity of air; and when, on expiration, the chest subsides, it presses on this large volume of air, which finds its exit restricted. A high and sustained positive pressure is thus built up. One can demonstrate this by closing the mouth and nose and making expiratory efforts. This observation explains why one takes a deep breath to increase the intrapulmonary pressure before coughing or sneezing.

It is only during expiration that the gradient is sufficient to force more oxygen into the blood. Here, the nose acts like a supercharger in a pressurized cabin of an airplane, except that it compresses the air at its exit rather than at its entrance.

The principle of incorporating mechanical resistance to nasal airflow is employed in aviation in the form of positive pressure breathing (continuous or intermittent) to improve the performance of an aviator at a given altitude or to raise the altitude at which a given performance can be maintained.[19]

Armstrong[11] states, "When the partial pressure of the inspired oxygen is reduced by $\frac{1}{7}$ the alveolar oxygen partial pressure is reduced to $\frac{1}{23}$." Pressman[13] observes:

> For every unit of increase of total intrapulmonic pressure there will be an increase of three times the partial pressure of oxygen. It is apparent that only a relatively small increase in intraalveolar pressure is capable of producing favorable physiologic effects.

The nose, by regulating the pressures, also assists in the process of mixing the respiratory and alveolar air. This mixture provides for a better and a more economical utilization of the air[12] (fig. 15). At the start of inspiration the bronchioles dilate, with a consequent fall in pressure. The filling of the bronchioles is retarded, however, by the narrowing of the nasal passage. At this time the pressure in the alveoli is higher than in the dilated bronchioles, since up to now the pressure in the thoracic cavity has not been reduced to any marked degree. Therefore, air will rush out of the alveoli into the bronchioles, where it will mix with the supply coming in from the atmosphere. As inspiration proceeds, the thorax enlarges and the diaphragm descends. The resultant negative pressure causes the mixed air in the bronchioles to be forced into the distended alveoli (fig. 15).

At the beginning of expiration the bronchioles contract. The nasal canal and the "choking" effect of the larynx offer obstruction to the exit of air; since the pressure in the alveoli is still low (because relaxation of the thoracic and abdominal walls has only just commenced), some of the air from the bronchioles is forced

19. Sternstein, H. J.: Quantitative Study of Nasal Obstruction: New Method, Arch. Otolaryng. **23**:475 (April) 1936; Dynamics of Nasal Respiration, Bull. New England M. Center **4**:28 (Feb.) 1942. Sternstein, H. J., and McGregor, J. B.: Effect of Nasal Ventilation upon Tubal Equalizing Efficiency in Flying Personnel, J. Aviation Med. **15**:244 (Aug.) 1944. Barach, A. L., and others: Studies on Positive Pressure Respiration: Subjective, Clinical and Psychological Effects of Continuous Positive Pressure Breathing at High Altitudes, J. Aviation Med. **18**:252 (June) 1947.

back into the air sacs. At the end of expiration the pressure increases and the air passes out into the bronchioles. At the beginning of the next inspiration the bronchioles relax, and the cycle is repeated.[12]

To summarize, the air flows from the alveoli to the bronchioles at the beginning of inspiration; from the bronchioles to the alveoli during the remainder of inspiration; from the bronchioles to the alveoli at the beginning of expiration, and from the alveoli to the bronchioles during the remainder of expiration.

In oral breathing the pressures are too quickly equalized to permit adequate mixing of air.

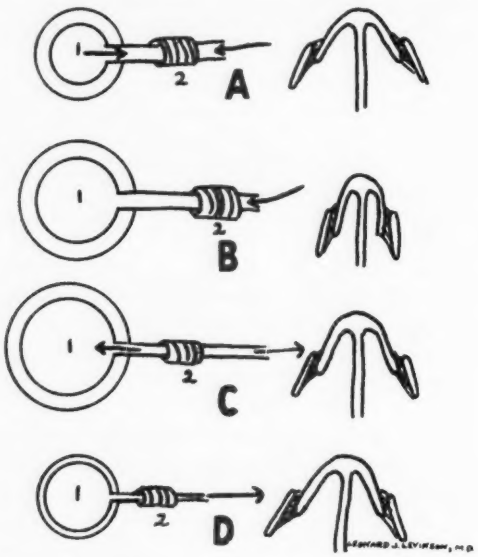


Fig. 15.—Effect of nasal cartilages on air-mixing in alveoli. *A*, beginning of inspiration; *B*, end of inspiration; *C*, beginning of expiration, and *D*, end of expiration. *1*, alveolus; *2*, bronchiole. From Negus.[12] See text.

## CIRCULATORY PHASE

The circulatory phase deals with the transportation of oxygen from the alveoli to the tissues and the removal of carbon dioxide from the tissues. The intimate relationship between respiration and circulation under normal as well as pathological conditions is indisputable. The one function cannot exist apart from the other. Only in combination are they capable of fulfilling their vital obligation for the benefit of the organism. What part does the nose play in this phase?

The left side of the heart is a propulsion pump. Its force is absorbed by the friction set up as the blood rubs against the walls of the vessels. By the time the blood reaches the veins, this force is exhausted. What, then, brings the blood back to the right side of the heart?

Unassisted, the left side of the heart would have difficulty in returning the blood to the right side, were it not for the material aid furnished by the respiratory tract in the following manner: The return flow is materially benefited by the nega-

tive pressure resulting from the enlargement of the chest on inspiration. The negative pressure thus created not only sucks air into the lungs but also sucks blood from the extrathoracic into the intrathoracic veins (*vis a fronte*). The physiologists [14] call this the aspiratory action of the thorax. At the same time the descending diaphragm assists the return flow by increasing the intra-abdominal pressure and squeezing blood out of the viscera. Since the blood is prevented by the presence of valves from passing downward, it is propelled upward.

The higher the negative pressure developed in the chest, the greater the assistance rendered to the right side of the heart. Since the nose, as stated above, materially aids in bringing about a higher negative pressure, nasal breathing is of considerable benefit to the heart. In oral respiration, with its superficial excursions and small fluctuations in pressure, this benefit is lacking, and the venous return is not equally favored. Perhaps the cardiologist would do well to consult with the rhinologist in some cases of decompensating heart lesions.

At the beginning of inspiration there is an increased flow of venous blood to the right side of the heart, but since, at the same time, the capacity of the pulmonary

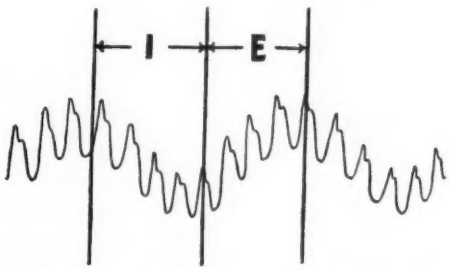


Fig. 16.—Graph showing effect of respiration on arterial blood pressure. *I*, inspiration; *E*, expiration (Best and Taylor [9]).

vessels is increased by dilatation of the lung capillaries, the added volume of blood cannot make itself felt in terms of pulse volume [9] (fig. 16). Only after the widened bed in the latter part of inspiration is fully filled does the left side of the heart also receive a greater blood supply and pulse volume increase.

With the beginning of expiration the venous return is checked by the increase in intrathoracic pressure. But this increase does not at once affect the pulse volume. As a result of the relaxation of the thoracic cage, the blood is squeezed out of the lungs, so that the left side of the heart does not suffer from a deficiency and the pulse volume continues to increase. In the later phase of expiration the deficiency is manifested by a gradually diminishing pulse volume.

It would seem that inasmuch as the negative pressure affects all intrathoracic structures equally, the same factors which draw the venous blood back to the heart should impede the escape of arterial blood from the thorax and that the effects taken together would offset each other without benefit to the circulation. But a moment's reflection discloses that this is not the case, for the arteries with their more rigid walls and greater intravascular pressure offer a greater resistance and are thus less affected by the negative pressure than are the veins.

Nasal breathing not only assists the action of the heart but also aids in maintaining the composition of the alveolar air (fig. 17).

An obvious question is why the carbon dioxide content of the alveoli does not fall on inspiration and rise on expiration. At the beginning of inspiration the air rushing into the alveoli would tend to lower the carbon dioxide percentage. But at the same time an increasingly large volume of blood rushes through the alveolar capillaries (fig. 17), and from them an amount of carbon dioxide sufficient to maintain the carbon dioxide level is sent into the alveoli. On expiration the reverse takes place. Here the dilution of carbon dioxide in the alveoli is less, but the carbon dioxide content remains constant, because the volume of blood flowing through the lungs is diminished as a result of the increase in intrathoracic pressure.

Failure of the muscles in effort is due more to the inability of transportation than to a deficiency in the supply of oxygen. Even with the body in repose, the blood is saturated with oxygen on leaving the alveoli. In exercise, when the tissues

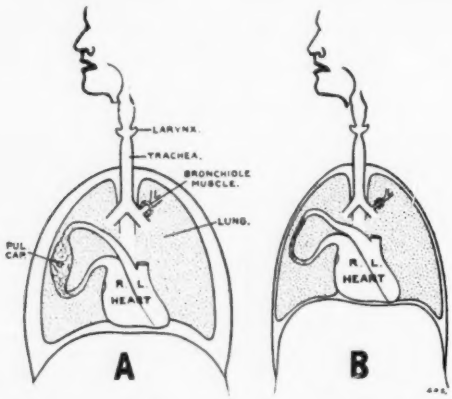


Fig. 17.—Diagram to illustrate dilation of pulmonary capillaries during inspiration and their collapse during expiration. (Modified after Negus.[12]) For details, see text.

require a greater amount of oxygen per unit of time, the increased demand must be met through an increase in cardiac output and rate. According to Best and Taylor,[9] in strenuous exercise only a fraction of the oxygen required is breathed during the course of the exercise. In a race of 100 yards (90 meters), which takes only a few seconds to run, 6 liters or more of air are required. Yet, the quantity of oxygen that can be absorbed in this time is less than 1 liter. The sprinter goes into debt for oxygen during the race and pays up after the race has been run. To bring a greater supply of oxygen to the tissues, the blood must circulate more rapidly and the cardiac output must be increased. (As much as 35 liters of blood must be put out by the heart.) This expenditure requires a greater venous return, which, in large measure, as has been mentioned before, depends on the negative pressure developed in the thorax.

A question has been put to us: If nasal respiration is so superior to oral, why in strenuous excerise, such as professional running, is it abandoned in favor of oral breathing? We believe that the increased rapidity of the respiratory efforts assists

the action of the heart, and that the benefits derived from this assistance outbalance the detriment to ventilation.

This observation is confirmed by Army experience. During a strenuous march soldiers with a nasal obstruction are the first to fall out, with symptoms of a cardiac rather than an oxygen deficiency.

Another factor essential to the restoration of function by a rhinoplastic operation is an accurate appraisal of the indication for surgical procedure. The type of obstruction must be determined. Clinically, it may be (1) inspiratory—interference with ingress but not with egress of air (e. g., collapsing ala); (2) expiratory—interference with egress but not with ingress of air (e. g., ball-valve polyps), or (3) combined inspiratory and expiratory (e. g., deflected septum).

General systemic conditions, such as dietary and hydration defects, allergy and cardiovascular disturbances, which may cause nasal obstruction, must be ruled out. Here we physicians must acquaint ourselves with the modern advances in general medicine and surgery. In this connection, we should like to cite Mosher,[20] who, in his presidential address before the American Laryngological Association made the following comment in regard to laryngology which is equally applicable to rhinology:

> It is only by frankly accepting as part of the specialty the subjects in medicine and surgery that border on laryngology that it can retain its vitality, that it can offer a full medical life and attract and win the better class of recruits.

The cause of the obstruction may be local and lie in the upper lateral cartilages, the lower lateral cartilages, the connecting aponeurosis, the septum or in the shape and inclination of the nares.

A simple practical test to check nasal function before and after operation would be a great contribution to rhinoplastic surgery. Unfortunately, we have been unable to find any such test. Perhaps some of those employed by the thoracic surgeon, internist or physiologist could be modified to serve the purpose; to mention a few, radiological tests, spirometric tests and those designed to measure residual air, minute ventilation and breathing reserve. A single example which may suffice to demonstrate the applicability of such tests to rhinology [21] is that used to estimate the maximum breathing capacity—i. e., the greatest volume of air that can be ventilated in one minute expressed in liters per minute. The respiratory air is collected in a Douglas bag and expressed from the bag through a gas meter. The mean values are 150 liters per minute for males and 100 liters per minute for females. Thus, if the maximum is 150 liters per minute and ventilation at rest equals 5 liters per minute, the breathing reserve is 145 liters and the ratio is as follows:

$$\frac{\text{Breathing reserve plus 100 at rest} \ldots\ldots 145}{\text{Maximum breathing capacity} \ldots\ldots 150} = 96.6 \text{ per cent.}$$

It is claimed that the threshold of dyspnea is reached when the breathing reserve is reduced to 60 to 70 per cent of maximum capacity.

20. Mosher, H. P.: Address of the President, Report of the Twenty-Sixth Meeting, Tr. Am. Laryng. A. **26**:1, 1920.

21. Cournand, A., and Richards, D. W., Jr.: Pulmonary Insufficiency: Discussion of Physiological Classification and Presentation of Clinical Tests, Am. Rev. Tuberc. **44**:26 (July) 1941.

For the facts presented here we claim no originality, but we must assume responsibility for their clinical application. Despite our every care to avoid bias, we may have erred in reasoning, but the subject is so vital to rhinology that we feel justified in presenting the paper. We hope it will prove sufficiently provocative to offset its shortcomings.

SUMMARY

An attempt is made to correlate nasal physiology with rhinoplastic surgery. The phylogenetic and ontogenetic development of the nose to meet a physiological need is discussed; the physiological, clinical and surgical importance of the nares is stressed; the relationship between deformities of the external nasal pyramid and function is described; the role played by the nose in regulating intrathoracic, sinus and middle ear pressures is reviewed; the manner in which the nose prevents hyperventilation or hypoventilation is demonstrated; the effect of nasal stenosis on lung ventilation and air mixing is shown, and the aid given by the nose to the cardiovascular system is elaborated.

# FACTORS INFLUENCING LATE SECONDARY HEMORRHAGE FOLLOWING TONSILLOADENOIDECTOMY

WILLIAM K. WRIGHT, M.D.
HOUSTON, TEXAS
AND
LAURENCE G. PRAY, M.D.
FARGO, N. D.

LATE SECONDARY hemorrhage following tonsilloadenoidectomy is an important question to the otolaryngologist. In the last decade it has been the subject of much investigation. Possible factors are acetylsalicylic acid intake, vitamin K and D deficiencies, excessive surgical trauma, infection, menstruation, abnormally large blood supply, liver disease, syphilis, pregnancy and blood dyscrasias. Of these, postoperative use of acetylsalicylic acid has been suspected of being the commonest cause. The ground work for this suspicion was laid by Link and associates,[1] Rapoport and associates,[2] Meyer and and Howard,[3] Shapiro and associates [4] and others who showed that a hypoprothrombinemia could be induced in animals and man by oral or intravenous administration of salicylates. This effect could be prevented or cured by vitamin K. Later Neivert [5] corroborated these laboratory findings and suggested that this effect might be an important cause of late secondary bleeding after tonsillectomy. He reported that a former incidence of about 10 per cent secondary bleeding was reduced to 1.4 per cent in 283 tonsillectomies in which vitamin K as well as acetylsalicylic acid was used postoperatively. Almost at the same time, Singer [6] reported no bleeding in a small group of 75 tonsillectomies in which aminopyrine was used postoperatively instead of acetylsalicylic acid. He said that in the clinics of Central Europe in which no acetylsalicylic acid was ever used, secondary hemorrhage after tonsillectomy was a rare complication. Neivert and associates [7] later reported a similar beneficial effect from vitamin C on salicylate-produced hypoprothrombinemia. They found that 19 of 21 secondary

1. Link, K. P.; Overman, R. S.; Sullivan, W. R.; Huebner, C. F., and Scheel, L. D.: Studies on the Hemorrhagic Sweet Clover Disease, J. Biol. Chem. **147**:463 (Feb.) 1943.

2. Rapoport, S.; Wing, M., and Guest, G. M.: Hypoprothrombinemia After Salicylate Administration in Man and Rabbit, Proc. Soc. Exper. Biol. & Med. **53**:40 (May) 1943.

3. Meyer, O. O., and Howard, B.: Production of Hypoprothrombinemia and Hypocoagulability of the Blood with Salicylates, Proc. Soc. Exper. Biol. & Med. **53**:234 (June) 1943.

4. Shapiro, S.; Redish, M. H., and Campbell, H. A.: Studies on Prothrombin in Man, Proc. Soc. Exper. Biol. & Med. **53**:251 (June) 1943.

5. Neivert, H.: Late Secondary Tonsillar Hemorrhage, Arch. Otolaryng. **42**:14 (July) 1945.

6. Singer, R.: Acetylsalicylic Acid: A Probable Cause for Secondary Post-Tonsillectomy Hemorrhage, Arch. Otolaryng. **42**:19 (July) 1945.

7. Neivert, H.; Pirk, L. A., and Engelberg, R.: Late Secondary Tonsillar Hemorrhage, Arch. Otolaryng. **43**:568 (June) 1946.

bleeders after tonsillectomy in a group of 246 patients who used acetylsalicylic acid were those with vitamin C blood levels before or shortly after tonsillectomy of less than 0.5 mg. per 100 mg. Vitamin C blood levels are generally not considered dependable indexes of ascorbidity; however, the 8.5 per cent bleeding incidence in this control group dropped to 4.1 per cent in 197 tonsillectomies after which supplemental vitamin C was administered. Preston [8] showed a decrease from 5.2 per cent late secondary bleeding after tonsillectomy in 1,423 patients who used acetylsalicylic acid to 1.95 per cent in 1,837 patients who used acetylsalicylic acid plus vitamin K.

While there is unanimity of opinion that acetylsalicylic acid does produce hypoprothrombinemia, many investigators feel that the dose necessary to produce this effect is never reached by the tonsillectomized patient. Butt and associates [9] state that doses of 50 grains (3.2 Gm.) a day had no effect on the prothrombin time. Coombs and associates [10] state that doses of 100 grains (6.5 Gm.) a day also had no effect. Higley [11] feels that doses up to 150 grains (9.7 Gm.) a day do not cause a clinically significant effect on the prothrombin time. Livingston and Neary [12] studied a group of 45 tonsillectomies after which the patients had chewed acetylsalicylic acid gum, 20 grains (1.3 Gm.) a day. Sixteen of these patients had supplemental vitamin K. They found that the prothrombin time was unaffected by either medicative routine. The three patients who bled postoperatively had normal prothrombin times. Quick [13] states that acetylsalicylic acid-induced hypoprothrombinemia has never been reported in such magnitude (less than 20 per cent of normal) as to cause hemorrhage. However, he does admit that acetylsalicylic acid can cause bleeding tendencies (e. g., thrombocytopenic purpura, etc.) by other means. Kark and Souter [14] have reported, however, that spontaneous bleeding from pathological surfaces, as wounds and ulcers, may occur with prothrombin levels of 35 per cent. The granulating tonsil fossa would probably constitute such a surface. Other dissenting opinions are Fishman and Lebo's,[15] who found only a 0.5 per cent secondary bleeding incidence in 341 patients who used acetylsalicylic acid freely with no supplemental vitamin K or C. They attribute their success to the use of the Beck snare, which considerably reduces the surgical trauma.

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8. Preston, H. G.: Postoperative Tonsil Bleeding: Studies of the Etiology, Prevention and Management, Laryngoscope **59**:251 (March) 1949.

9. Butt, H. R.; Leake, W. H.; Solley, R. F.; Griffith, G. C.; Huntington, R. W., and Montgomery, H.: Studies in Rheumatic Fever: I. The Physiologic Effect of Sodium Salicylate on the Human Being with Particular Reference to the Prothrombin Level of the Blood and the Effect on Hepatic Parenchyma, J. A. M. A. **128**:1195 (Aug. 25) 1945.

10. Coombs, F. S.; Warren, H. A., and Higley, C. S.: Toxicity of Salicylates, J. Lab. & Clin. Med. **30**:378 (April) 1945.

11. Higley, C. S.: Use of Salicylates in Rheumatic Fever—Mixture of Aspirin and Vitamin K Unwarranted, J. A. M. A. **129**:1123 (Dec. 15) 1945.

12. Livingston, G. S., and Neary, E. R.: The Question of Prothrombinopenic Hemorrhage from Post-Tonsillectomy Use of Chewing Gum Containing Acetylsalicylic Acid, Arch. Otolaryng. **47**:1 (Jan.) 1948.

13. Quick, A. J.: Salicylates and Hemorrhage, J. A. M. A. **126**:1167 (Dec. 30) 1944.

14. Kark, R., and Souter, A. W.: Hypoprothrombinemia and Avitaminosis K in Man, Brit. M. J. **2**:190 (Aug. 9) 1941.

15. Fishman, V. P., and Lebo, C. P.: Post-Tonsillectomy Hemorrhage, Bull. Pract. Ophth. **17**:1 (July) 1947.

Another theory concerning acetylsalicylic acid as a possible cause of secondary bleeding after tonsillectomy is proposed by Fox and West.[16] They consider that acetylsalicylic acid may have a local hemorrhagic effect. They found no difference in bleeding with or without administration of vitamin K when the patient used acetylsalicylic acid locally, as acetylsalicylic acid-containing gum. However, complete elimination of the use of acetylsalicylic acid resulted in a considerable drop in the bleeding incidence. This theory would be supported by work done by Ersner and associates,[17] who showed that saliva mixed with blood resulted in a reduction of the coagulation time, while saliva mixed with blood and salicylates resulted in a considerable prolongation of the clotting time. The theory of a local hemorrhage effect caused by acetylsalicylic acid would not explain, however, the

TABLE 1.—*Reported Cases of Bleeding After Tonsillectomy and Administration of Acetylsalicylic Acid*

| Author | Medicine | Number Cases | Number Bleeding | Percentage Bleeding | Percentage Serious Bleeding |
|---|---|---|---|---|---|
| Livingston | Aspergum ® | 29 | 2 | 6.6 | .. |
| Fox | Aspergum ® | 199 | 17 | 8.5 | 4 |
| Livingston | Aspergum ® & vitamin K | 16 | 1 | 6.3 | .. |
| Fox | Aspergum ® & vitamin K | 188 | 13 | 10.5 | 5 |
| Coombs | Aspergum ® & vitamin K | 164 | 12 | 7.3 | 3 |
| Coombs | Aspergum ® & vitamin C | 179 | 25 | 14. | 7 |
| Coombs | Aspergum ® & vitamins C & K | 310 | 32 | 10. | 1 |
| Totals | | 1,085 | 102 | 63.2 | 20 |

TABLE 2.—*Reported Cases of Bleeding After Tonsillectomy with No Administration of Acetylsalicylic Acid*

| Author | Medicine | Number Cases | Number Bleeding | Percentage Bleeding |
|---|---|---|---|---|
| Singer | Aminopyrine | 75 | 0 | 0.0 |
| Fox | No medicine | 184 | 2 | 1.0 |
| Fox | Tyrothricin and ethyl aminobenzoate * | 159 | 0 | 0.0 |
| Totals | | 418 | 2 | 0.5 |

* Benzocain.[20]

high incidence of secondary bleeding after adenoidectomy noted by Coombs.[18] Those who have investigated acetylsalicylic acid used locally as a gum have generally found late secondary bleeding in 6 to 14 per cent of the patients, with no reduction in the incidence when vitamin C or K was administered.

A small number of cases in which these investigators eliminated acetylsalicylic acid completely, however, had a greatly reduced incidence of secondary bleeding.

16. Fox, S. L., and West, G. W., Jr.: Vitamin K and Late Tonsillar Hemorrhage, Laryngoscope **57**:564 (Aug.) 1947. Fox, S. L., and West, G. W., Jr.: Vitamins and Late Tonsillar Hemorrhage, Bull. School Med. Univ. Maryland **32**:215 (April) 1948.

17. Ersner, M. S.; Myers, D., and Ersner, W.: A Clinical and Experimental Study of the Action of Saliva on Blood Coagulation and Wound Healing in Surgery of the Oral Cavity and Throat, Ann. Otol., Rhin. & Laryng. **43**:114 (March) 1934.

18. Coombs, A. J.: A Study of Delayed Bleeding Following Removal of the Tonsils and Adenoids, Laryngoscope **60**:296 (March) 1950.

SERIES 1 (411 TONSILLOADENOIDECTOMIES)

The present series consists of 1,648 tonsilloadenoidectomies. In a small per cent of the cases tonsillectomy only or adenoidectomy only was done. The first 411 cases were used to study the effect of vitamin C on secondary bleeding. In the last 1,237 cases a study was made of the effect of elimination of acetylsalicylic acid on secondary bleeding. Bleeding on the second postoperative day and later was considered secondary and was recorded according to the following scale:

1 + Any bleeding, no matter how slight (e. g., spot of blood on the pillow, clot of blood in spit, etc.).

2 + Severer bleeding (e. g., patient bled from nose for two or three minutes, vomited a small amount of blood or clots).

TABLE 3.—*Effect of Vitamin C on Secondary Bleeding After Tonsillectomy*

| | Control Group | | Vitamin C Group | | Combined |
|---|---|---|---|---|---|
| Number of patients followed | 233 | | 178 | | 411 |
| Total secondary hemorrhage | 18 (7.7%) | | 13 (7.2%) | | 31 (7.5%) |
| Severe secondary hemorrhage (3+ or 4+) | 4 (1.7%) | | 6 (3.3%) | | 10 (2.5%) |
| Secondary Bleeding, No. | Post-operative Day | Amount of Bleeding | Post-operative Day | Amount of Bleeding | |
| 1 | 2 | 2+ | 5 | 3+ | |
| 2 | 2 | 2+ | 4 & 6 | 3+ | |
| 3 | 5 | 2+ | 0, 1, 2 & 3 | 3+ | |
| 4 | 6 | 2+ | 3 | 1+ | |
| 5 | 5 & 6 | 2+ | 5 | 3+ | |
| 6 | 7 & 9 | 3+ | 2 | 2+ | |
| 7 | 10 | 1+ | 2 | 1+ | |
| 8 | 4 | 1+ | 8 | 1+ | |
| 9 | 6 | 3+ | 2 | 1+ | |
| 10 | 3 | 2+ | 5 | 3+ | |
| 11 | 4 | 1+ | 2, 3 & 4 | 2+ | |
| 12 | 6 | 1+ | 5 & 6 | 3+ | |
| 13 | 2 | 2+ | 5 | 1+ | |
| 14 | 6 | 1+ | .. | ... | |
| 15 | 1, 2, 3 &4 | 2+ | .. | ... | |
| 16 | 6 | 4+ | .. | ... | |
| 17 | 7 | 3+ | .. | ... | |
| 18 | 2 | 2+ | .. | ... | |

3 + Moderately severe bleeding (patient sought medical attention, or it was estimated from the history that there was more than 150 cc. blood lost).

4 + Severe bleeding (requiring repeated blood transfusions, supportive therapy, etc.; the condition of the patient considered more or less critical).

SERIES 1 (411 TONSILLOADENOIDECTOMIES)

All these were children operated on at Children's Memorial Hospital in Chicago in 1947 to 1948. The operation was done by the Beck-LaForce method. All were followed in the office for at least 10 days after the operation. All patients were allowed free use of acetylsalicylic acid, but alternate patients received, in addition, vitamin C [19] (150 mg. the day before the operation, 150 mg. the day of the operation, and 100 mg. a day for the next 10 days [20]). The remaining patients

19. The vitamin C was furnished through the courtesy of Eli Lilly & Company.

20. These doses are about half those used by Neivert, but these patients were all children; his were adults.

were used as controls. No record was made of acetylsalicylic acid intake, but patients who did not take their vitamin C were excluded from this series. If this omission was complete, they were included in the controls.

*Comment.*—This group is too small to show minor trends, but it can be said that vitamin C does not appear to have any startling anti-secondary-hemorrhage factor after tonsillectomy.

These children were charity patients from poor families, and the vitamin C intake of the control group before and after tonsillectomy was probably less than would have been encountered in a similar series from middle class families. There were, however, no cases of clinical scurvy.

Nine out of 10 cases of severe (3 + or 4 +) secondary bleeding occurred on the fifth, sixth or seventh postoperative day. The exception was a patient who bled the day of the operation and for the next three days. This case probably

TABLE 4.—*The Effect of Acetylsalicylic Acid on Secondary Hemorrhage After Tonsillectomy*

| | Children (Received Vitamin K) | | | | |
|---|---|---|---|---|---|
| | Used Acetylsalicylic Acid | | No Acetylsalicylic Acid | | Combined |
| No. of patients followed | 23 | | 644 | | 667 |
| Total secondary bleeding | 4 (17.4%) | | 10 (1.5%) | | 14 (2.1%) |
| Severe secondary bleeding (3+ or 4+) | 0 (0%) | | 2 (0.3%) | | 2 (0.3%) |
| Secondary Bleeding, No. | Post-operative Day | Amount of Bleeding | Post-operative Day | Amount of Bleeding | |
| 1 | 8 | 2+ | 5 | 1+ | |
| 2 | 4 | 2+ | 3 | 1+ | |
| 3 | 4 | 2+ | 3 | 1+ | |
| 4 | 4 | 1+ | 2 | 1+ | |
| 5 | .. | ... | 7 | 3+ | |
| 6 | .. | ... | 7 | 2+ | |
| 7 | .. | ... | 4 | 1+ | |
| 8 | .. | ... | 5 | 1+ | |
| 9 | .. | ... | 6 | 3+ | |
| 10 | .. | ... | 7 | 1+ | |

represents a continuation of the primary bleeding due to repeated dislodging of blood clots and probably should not have been recorded as secondary bleeding. Secondary bleeding after the seventh postoperative day was uncommon and when present was mild.

SERIES 2 (740 TONSILLOADENOIDECTOMIES)

These cases consisted of 82 tonsillectomies performed on adults with local anesthetic and 667 tonsilloadenoidectomies performed on children with vinyl ether (vinethene®) and ether anesthetics. All these operations were done at St. Luke's Hospital, Fargo, N. D., and the patients received a preoperative physical examination, blood count, test for bleeding and coagulation time and urinalysis. All received vitamin K, 2 mg. twice daily for one to three days preoperatively and for seven days postoperatively. The adults received, in addition, 200 mg. of vitamin C daily over the same period. Tonsils were removed with the Beck snare except when scarring necessitated dissection. Adenoids were removed with five applications of the LaForce adenotome (once in the midline high, once to each side in contact with the torus tubarius and once to each side below the torus tubarius and as far laterally as possible). This was followed by routine use of the Rosenmüller

fossa curet behind the eustachian tubes. The blood vessels of persistent bleeders were tied with surgical gut slip knots. The incidence of primary bleeding was 1.8 per cent, all occurring after tonsillectomy. There was no primary bleeding after adenoidectomy. All patients were cautioned against the use of acetylsalicylic acid in any form (gum or tablets) at any time postoperatively. They were given tyrothricin and ethyl aminobenzoate lozenges instead. All patients were also followed in the office, by mail or by phone, for at least seven days postoperatively. Patients were questioned about bleeding and abstinence from acetylsalicylic acid. They were then instructed to return or to contact the physician if any bleeding occurred after they left the office.

*Comment.*—One child took 20 grains (1.3 Gm.) of acetylsalicylic acid a day. The rest took 10 grains (0.7 Gm.) or less a day usually for less than five days after the operation. One of the two patients who chewed acetylsalicylic acid gum bled. Only three of the 10 (0.48 per cent) bleeders in the group abstaining from acetyl-

TABLE 5.—*Effect of Acetylsalicylic Acid on Secondary Hemorrhage After Tonsillectomy*

| | Adults (Received Vitamin K and C) | | | | |
|---|---|---|---|---|---|
| | Used Acetylsalicylic Acid | | No Acetylsalicylic Acid | | Combined |
| No. of patients followed | 50 | | 32 | | 82 |
| Total secondary bleeding | 10 (20%) | | 1 (3%) | | 11 (13.4%) |
| Severe secondary bleeding (3+ or 4+) | 5 (10%) | | 0 (0%) | | 5 (6.1%) |
| Secondary Bleeding, No. | Post-operative Day | Amount of Bleeding | Post-operative Day | Amount of Bleeding | |
| 1 | 3 | 2+ | 4 | 1+ | |
| 2 | 5 & 6 | 3+ | .. | ... | |
| 3 | 5 & 6 | 3+ | .. | ... | |
| 4 | 7 | 3+ | .. | ... | |
| 5 | 7 | 3+ | .. | ... | |
| 6 | 7 | 2+ | .. | ... | |
| 7 | 5 | 2+ | .. | ... | |
| 8 | 5 | 1+ | .. | ... | |
| 9 | 8 | 3+ | .. | ... | |
| 10 | 7 | 1+ | .. | ... | |

salicylic acid bled more than very slighty (+). None of these three patients lost more than 200 cc. of blood.

*Comment.*—Sixty-one per cent of the adults ignored the warning against acetylsalicylic acid. All these chewed acetylsalicylic acid in gum and usually took tablets of acetylsalicylic acid in addition, averaging about 40 grains (2.6 Gm.) a day. This undoubtedly represents the increased degree of soreness in adults after tonsillectomy over that in children.

Investigators in this subject currently feel that significant data require not only many but well followed cases, recording of even slight bleeding and also noting of whether or not the patient took the prescribed medicine and in what amount. However, because of the very low incidence of severe secondary bleeding in this series of tonsilloadenectomies (0.3 per cent), it was felt that it would be interesting to compare it with a similar series in preceding years in which the patients received vitamin K but also used acetylsalicylic acid-containing gum and oral acetylsalicylic acid tablets. We have no reliable record of the acetylsalicylic acid intake over this period, but the patients were instructed to take acetylsalicylic acid-containing gum three times a day before meals and to use acetylsalicylic acid tablets as necessary.

They also received vitamin K, 2 mg. a day for the same period as the present series. Tonsils were removed by dissection and snare. Our hospital records show only bleeding severe enough to require medical attention (i. e., 3 + or 4 +). We feel that this is a dependable comparison, because like categories are compared in fairly large groups.

*Comment.*—Since the secondary bleeding was less than one-tenth as much when the use of acetylsalicylic acid was eliminated, we feel that its elimination is a significant factor in controlling late secondary bleeding following tonsilloadenoidectomy. Both groups received equal amounts of vitamin K. The lesser surgical trauma inflicted by the Beck snare has been mentioned as a possible factor in reduced bleeding. If this is actually a factor, it probably would not make this degree of difference.

## COMMENT

The effect of vitamin C on secondary post-tonsilloadenoidectomy bleeding was studied in 411 children at Children's Memorial Hospital in Chicago in 1947 to 1948. These children were allowed to take acetylsalicylic acid freely, but alternate patients received ascorbic acid, 150 mg. the day before the operation and 100 mg. daily for 10 days. No appreciable antihemorrhagic effect resulted from administration of

TABLE 6.—*Effect of Acetylsalicylic Acid on Secondary Hemorrhage After Tonsillectomy**

| Children (Received Vitamin K) | Dates Followed | No. of Tonsillo-adenoidectomies | Severe Bleeding (3+ or 4+) |
|---|---|---|---|
| Used acetylsalicylic acid | 9/29/47-4/4/49 | 488 | 18 (3.7%) |
| No acetylsalicylic acid | 4/5/49-7/1/50 | 644 | 2 (0.3%) |

* The ratio of aspirin®: no aspirin® = 3.7 : 0.3 = 12.3 (i. e., severe secondary bleeding was 12.3 times commoner when acetylsalicylic acid was used postoperatively).

vitamin C, as in the group taking vitamin C there was secondary hemorrhage in 7.2 per cent of the patients as compared with 7.7 per cent in those not taking vitamin C.

The effect of vitamin K and acetylsalicylic acid on post-tonsillectomy hemorrhage was studied in 667 children and 82 adults at St. Luke's Hospital, Fargo, N. D., in 1949 to 1950. All received vitamin K before and after the operation. Of the 667 children, 23 were given acetylsalicylic acid against advice, with secondary hemorrhage in 17.4 per cent. The remaining 644 children received no acetylsalicylic acid; there was secondary hemorrhage in 1.5 per cent. The 82 adults all received vitamin K and vitamin C. Fifty of the 82 took acetylsalicylic acid; the incidence of hemorrhage was 20 per cent. The 32 adults who did not take acetylsalicylic acid had a 3 per cent incidence of secondary hemorrhage.

We also compared the incidence of severe secondary hemorrhage in the 644 children receiving vitamin K but no acetylsalicylic acid with a group of 488 children who received vitamin K plus acetylsalicylic acid in 1947 to 1948. Severe secondary bleeding was 12 times more common when acetylsalicylic acid was used postoperatively. On the basis of our figures there is no evidence that vitamin K reduced secondary hemorrhage. In the 23 children who received both acetylsalicylic acid and vitamin K in 1949 to 1950, the incidence of hemorrhage was 17.4 per cent, as compared with 1.5 per cent incidence of hemorrhage in the 644 who were given vitamin K but no acetylsalicylic acid. A similar difference was found in adults.

## CONCLUSIONS

1. Acetylsalicylic acid given after tonsillectomy increases the incidence of late secondary hemorrhage. This is shown by the marked reduction in the incidence of secondary hemorrhage when acetylsalicylic acid is withheld. This increased bleeding incidence from the use of acetylsalicylic acid may be due to its local effect in the mouth.

2. Administration of vitamin C has no appreciable effect on secondary bleeding following tonsilloadenoidectomy.

3. Vitamin K taken before and after the operation appears to have no antihemorrhagic effect.

Hermann Professional Building (5).

Fargo Clinic.

# SUBMANDIBULAR FLAP

J. G. KOSTRUBALA, M.D.
AND
R. F. STOKES, M.D.
CHICAGO

SATISFACTORY cosmetic results in the repair of facial defects are dependent on many factors and demand that the repaired area be of a color and texture resembling the normal tissue of that region. Visible scars of the donor site must be kept at a minimum, lest a deformity as unsightly as the original be produced.

In recent literature [1] there has been a greater tendency to stress the value of using neighboring and contiguous flaps to obtain suitable color and texture matches, but in spite of this tendency, many procedures and technics which were introduced years ago continue to reappear with each new textbook on plastic surgery, even though the results of such procedures are unsatisfactory to patient and surgeon.

The bipedicle scalp flap (visor flap) used to repair defects of the upper lip is one that has been described in nearly every textbook, and because of this has assumed the importance of a standard plastic surgery procedure. It is, however, a method that often does not produce a desirable cosmetic result. The texture of scalp skin is not like that of facial skin. The color match is nearly always unsatisfactory, unless the patient chooses to allow the hair to grow, thereby simulating a mustache. Such a method is certainly not suitable in the repair of facial defects and in the reconstruction of the lips of female patients.

This paper presents a technic of repairing extensive defects of the upper or lower lip and defects of the cheek by means of a bipedicle submandibular flap. We make no claim of originality and know that there are some surgeons who use this method, but because current American literature and recently published textbooks make no mention of this procedure, there is justification for this paper.

The skin and subcutaneous tissues of the submandibular region have qualities that make them ideal donors for the repair of facial defects. The color and texture requirements are satisfied. The scar of the donor area corresponds with the normal skin crease and remains inconspicuous, and those patients favored with a redundancy called a "double chin" may actually have the appearance of the donor site improved by the use of a submandibular flap. In male patients this method of repair is limited to the correction of defects of the hair-bearing facial skin; in women it has a wider range of usefulness.

1. Virenque, M.: Chirurgieréparatrice maxillo-faciale: Autoplastics, prothèse, restauration, Paris, Norbert Maloine, 1940. Ivy, R. H.: Plast. & Reconstruct. Surg. **1**:119, 1946. Macomber, W. B., and Berkeley, W. T.: Plast. & Reconstruct. Surg. **2**:585, 1947. Spreter, T.: Chirurg. **20**:474, 1949.

Blood is supplied to the integument of the submandibular area through terminal branches of the submental artery, a branch of the external maxillary artery; the sternocleidomastoid artery, a branch of the superior thyroid artery, and branches of the thyrocervical trunk. There are, however, no vessels that course transversely in this region, and the viability of the flap is dependent on the rich anastomosis in the dermal and subdermal plexuses.

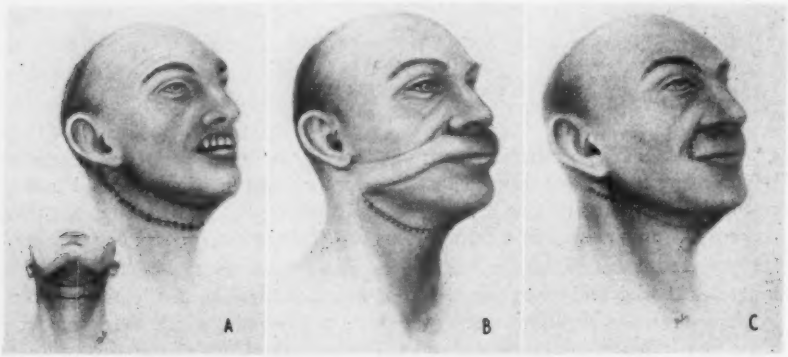


Fig. 1.—(*A*) The submandibular flap has been outlined, undermined and lined with skin in its central portion and sutured back into place. The dotted lines shown on the inset indicate the area of the flap lined with a split thickness graft. (*B*) The submandibular flap has been brought into place over the defect and sutured under the nose. The defect in the neck is closed with interrupted sutures. (*C*) The pedicles of the flap have been amputated, and the central portion of the flap has been sutured into the freshened skin edges at the lateral margin of the defect.

Fig. 2.—*A*, preoperative photograph of a patient with a traumatic loss of the upper lip. *B*, postoperative photograph of the same patient taken after the use of a submandibular flap.

## TECHNIC

Two incisions are made transversely in the submandibular region. The distance between the incisions is determined by the width of the lip to be reconstructed or the size of the defect to be repaired. The superior incision begins at a point

approximately 1 cm. behind and below the angle of the mandible and is carried forward and around the neck to end at a corresponding point behind the opposite mandibular angle. The second incision runs parallel to the first and at a predetermined distance below it. The flap is undermined in a plane superficial to the

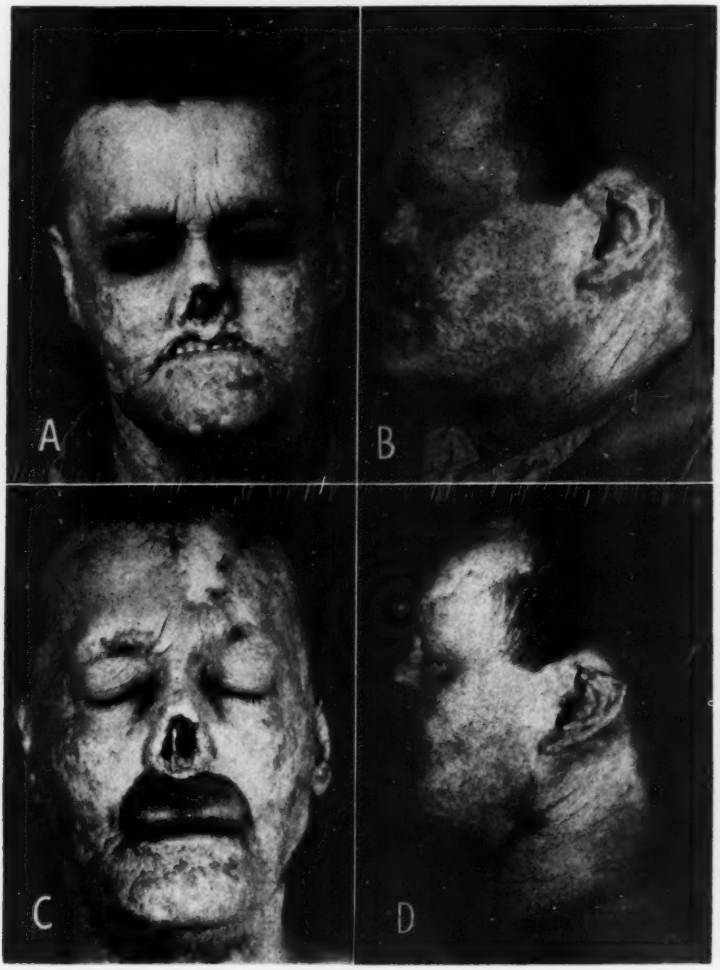


Fig. 3.—*A*, front view of a patient with a total loss of the upper lip and other deformities due to the surgical excision of multiple malignant growths. *B*, profile of same patient. *C*, postoperative photographs, front view, taken after the reconstruction of the upper lip by means of a submandibular flap (subsequent repair procedures). *D*, postoperative photographs, profile.

platysma muscle. The central portion of the flap may be lined with a split thickness graft to provide the lining for the newly constructed lip. The entire flap is then resutured into its bed, to constitute a delaying procedure (fig. 1 *A*).

At the next step the flap is raised and brought into its new position. The split thickness skin lining is sutured to the oral mucous membrane bordering the defect, and the skin of the flap is sutured to the skin of the face along the upper border of the defect. The donor site in the submandibular area is closed by undermining the skin and suturing the wound edges into apposition (fig. 1 *B*). It is important that the incisions be so placed that the final suture line will fall in the inconspicuous angle between the chin and the neck.

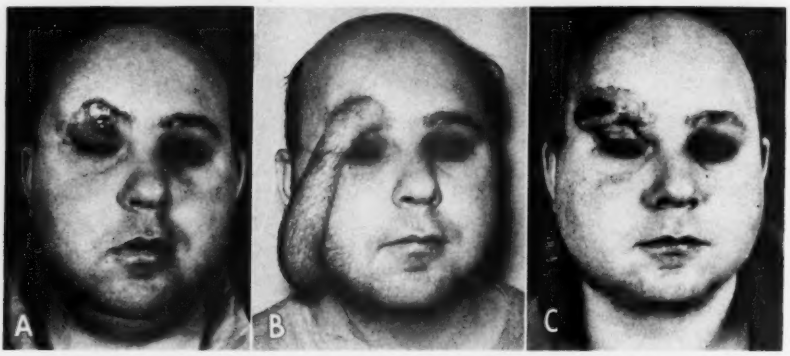


Fig. 4.—*A*, traumatic defect of the right frontal bone, with loss of frontal skin and absence of right eye. *B*, submandibular flap sutured into defect in right frontal region. *C*, postoperative picture of flap in new location and the simulated eyebrow resulting from the growth of hair from the flap.

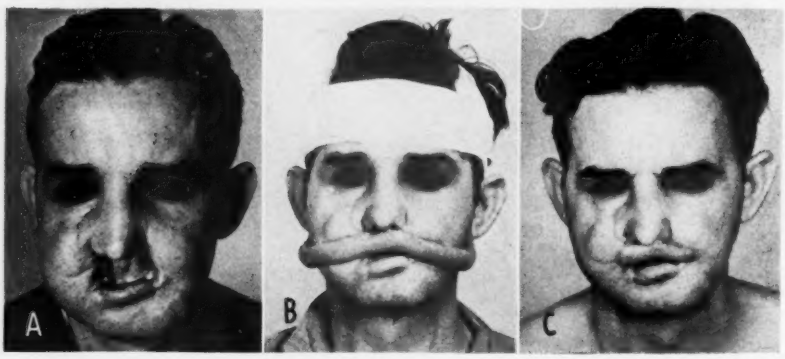


Fig. 5.—*A*, total loss of upper lip and portion of hard palate as the result of a war injury. *B*, submandibular flap sutured into defect of upper lip. *C*, appearance of the flap after sectioning of the pedicle prior to reconstruction of palate.

The final procedure may be completed in approximately three weeks after the second operation. It will be noted that if the pedicles were left open they will have converted themselves into tubes about this time. The pedicles are sectioned, leaving the central portion attached to the face below the nose. The raw surfaces of the central portion are sutured to the freshened lateral skin margins of the defect. The pedicles are amputated at their origins, and the wounds are closed

by suturing (fig. 1*C*). The establishment of a cupid's bow is not so important as it might seem; our patients were quite satisfied with their appearances and felt that a visible vermilion border was unnecessary. However, there are several methods, including tattooing, which may be used to provide the final touch in those patients who desire it.

With slight modifications this basic procedure may be used to reconstruct a lower lip and to repair defects of the cheek, and it may be useful in reconstructing eyebrows.

SUMMARY

The necessity of proper texture and color matching in the repair of defects of the face and lips is emphasized. The bipedicle submandibular flap is described. It is a relatively simple method of repairing certain facial defects and meets the requirements of suitable color and texture matching without leaving deforming scars at the donor site.

55 East Washington Street.

# LYMPH VESSELS IN THE WALL OF THE ENDOLYMPHATIC SAC

JÖRGEN ARNVIG, M.D.
COPENHAGEN, DENMARK

WITHIN recent years, much research has been devoted to the problem of the anatomy and physiology of the endolymphatic sac (Guild,[1] Bast,[2] Anson and Nesselrod,[3] Anson and Wilson,[4] Doi,[5] Siirala,[6] Secretan,[7] Altmann and Waltner,[8] Lindsay,[9] H. C. Andersen,[10] Engstrøm and Hjorth [11]).

Most writers agree that the endolymph is absorbed from the sac. This view is based on a series of experimental observations, which will be discussed later. The details, however, of this process of absorption are as yet unknown. Mygind [12] (1948) takes the view that certain highly molecular proteins are decomposed within the sac, whereas the low molecular ones are absorbed directly from the entire surface of the endolymphatic system.

The decomposition within the sac is assumed, by Mygind, to occur by means of large wandering cells—histiocytes—which are usually found in a copious number in the lumen of the sac. This fact has been described by several authors, such as Siirala [6] (1941) and Secretan [7] (1944).

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From the Ear Clinic of the Kommune Hospital.

Read before the Danish Society of Otolaryngology, May 8, 1950.

1. Guild, S. R.: The Structure and Normal Contents of the Ductus and Saccus Endolymphaticus in the Guinea Pig (Cavia Cobaya), Am. J. Anat. **39**:1-56, 1927.

2. Bast, T. H.: The Utriculo-Endolymphatic Valve, Anat. Rec. **40**:61-64, 1928.

3. Anson, B. J., and Nesselrod, J. P.: Endolymphatic and Associated Ducts in Man, Arch. Otolaryng. **24**:127-140 (Aug.) 1936.

4. Anson, B. J., and Wilson, J. G.: Form and Structure of Endolymphatic and Associated Ducts in the Child, Anat. Rec. **65**:485-498, 1936.

5. Doi, S. I.: Über die freien Zellen im Saccus endolymphaticus der Meerschweinchen, Okayama-Igakkai-Zasshi **50**:1674-1678, 1938; Zentralbl. f. Hals-, Nasen- Ohrenh. **31**:329, 1939.

6. Siirala, U.: Über den Bau und die Funktion des Ductus und Saccus endolymfaticus bei alten Menschen, Ztschr. f. Anat. u. Entwcklngsgesch. **111**:246-265, 1941.

7. Secretan, J. P.: De l'histologie normale du sac endolymphatique chez l'homme, Acta oto-laryng. **32**:119-163, 1944.

8. Altmann, F., and Waltner, J. G.: The Circulation of the Labyrinthine Fluids: Experimental Investigations in Rabbits, Ann. Otol., Rhin. & Laryng. **56**:684-708, 1947.

9. Lindsay, J. R.: Effect of Obliteration of the Endolymphatic Sac and Duct in the Monkey, Arch. Otolaryng. **45**:1-13 (Jan.) 1947.

10. Andersen, H. C.: Passage of Trypan Blue Into the Endolymphatic System of the Labyrinth, Acta oto-laryng. **36**:273-283, 1948.

11. Engstrøm, H., and Hjorth, S.: On the Distribution and Localization of Injected Dyes in the Labyrinth of the Guinea Pig, Transactions of the Eleventh Nordic Otolaryngologic Congress, Oslo, 1950, pp. 128-137.

12. Mygind, S. H.: Further Labyrinthine Studies: Affections of the Humoral System of the Labyrinth, Acta oto-laryng, 1948, supp. 68, pp. 1-50.

It is thought that these wandering cells arise in both the epithelial covering of the sac and in histiocytes from the surrounding connective tissue, where they are readily disclosed. Of the function of these cells, nothing is known. But by means of supravital staining it has been demonstrated by Kibata [13] (1929), Andersen [10] (1948), and Engstrøm and Hjorth [11] (1950) that the injected dye is absorbed by these cells, as distinct from the remaining cells in the endolymphatic system.

The perisaccular connective tissue has been uniformly described by different writers (such as Guild [1] and Siirala [6]) as a loose tissue that yields to variations of pressure (Secretan [7]). This tissue is, furthermore, highly vascularized. In human leukemia, Secretan [7] has, in addition to blood vessels, found lymph vessels

Fig. 1.—Perisaccular lymph vessel under considerable magnification. Note the protein precipitations and the mononuclear white blood cells. (Hematoxylin-eosin stain; × 900.)

filled with white blood corpuscles. It should be noted that, usually, it is difficult to make these lymph vessels visible.

## PERSONAL INVESTIGATIONS

The following observations are made in the endolymphatic sac of the normal guinea pig. The sac is grossly of the same anatomic structure as that found in human beings. Within the perisaccular connective tissue certain definite vessels are observed that do not contain blood but a fluid rich in proteins and white blood corpuscles. These vessels form an independent net of channels and, as has been mentioned above, are difficult to make visible and to reproduce photographically.

The vessels are found in the intermediary part only (consult Guild's [1] nomenclature); they are distinguished from the usual capillaries by having a large lumen

13. Kibata: Beiträge zur Vitalfärbung des Labyrinthes, Jap. Otolaryng. Ztschr. **33**:597, 1927; cited by Yamakawa, K.: Die Wirkung der arsenigen Säure auf das Ohr, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **123**:238-296, 1929.

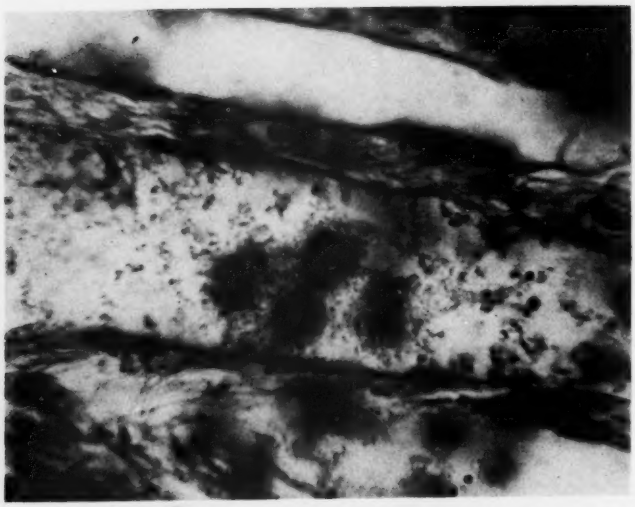

Fig. 2.—Perisaccular tissue. Perfused capillary above and lymph vessel below, containing protein "cloudings" and leukocytes. (Hematoxylin-eosin stain; × 900.)

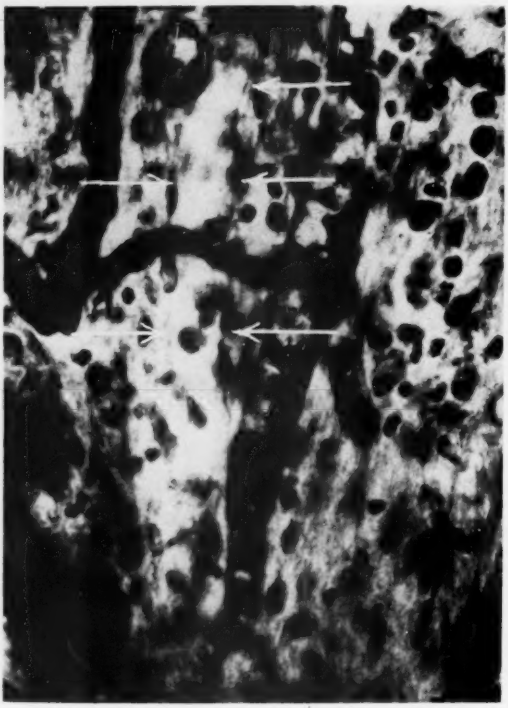

Fig. 3.—Perisaccular tissue. Capillaries injected with india ink. Parallel with one of the capillaries, a lymph vessel, with a vertical course, is seen. The lymph vessel contains white blood cells but no india ink. (Hematoxylin-eosin stain; × 700.)

and by the fact that they never contain erythrocytes. Besides proteins, a varying number of mononuclear and polynuclear white blood corpuscles are found in the vessels.

In the experiments the following technic has been used. Normal guinea pigs were anesthetized with ether. A cannula was inserted into the aorta and an incision made in the right atrium. The vessels were then perfused with a saline solution. The fixation fluid (Wittmaack's fluid *Kaformacet*) was injected in the same way. The preparation was fixed, decalcified and embedded in pyroxylin.

Fig. 4.—Section of the endolymphatic sac (intermediary part) under considerable magnification. Wandering cells are in the lumen. In the connective tissue are cross sectioned capillaries injected with india ink. In the middle is a large lymph vessel filled with lymphocytes. (Hematoxylin-eosin stain; × 700.)

In the illustrations, sections of the perisaccular tissue are demonstrated. Within the lymph vessels shown in figures 1 and 2 are a definite clouding, due to protein precipitations, and white blood cells. These cells are both mononuclear (fig. 1) and polynuclear (fig. 2).

In figure 2 there is a pronounced difference between the perfused capillary above and the lymph vessel below. Both these vessels have an endothelial lining.

In two other cases, 20 ml. of an india ink suspension was injected instead of Wittmaack's fluid. The animals were then decapitated, and the specimens were treated as has been described above.

In these preparations, the arteries, the arterioles and even the capillaries were filled with india ink. Part of the dye had passed into the large sinusoids. The intermediary part of the sac was richly vascularized. A highly developed capillary net with abundant anastomoses was disclosed here, coursing along and across the structure.

In figure 3 this capillary net is distinctly visible. Parallel with one of the injected vessels, a lymph vessel is seen. This vessel does not contain any dye, only some white blood cells (see the lowest arrows in figure 3).

In figure 4 a section of the epithelial lining of the sac is seen. There are some wandering cells in the lumen. Some capillaries filled with india ink are found cross sectioned. In the middle of the connective tissue is seen a wide vessel with an endothelial lining stuffed with lymphocytes.

It appears from these experiments that the concern is with an independent system of vessels with no connection with the blood vessel system, apart from the apparent outflow into the veins.

## COMMENT

Lymph vessels have not been demonstrated previously in the normal endolymphatic sac. The occurrence of such vessels in the perisaccular tissue may have some bearing on the function of the sac.

It has been assumed by Boettcher [14] (1870) and Hasse [15] (1881) that the endolymph was produced in the endolymphatic sac. When, at present, the opposite view is taken it is due, mainly, to Guild's [1] investigations.

These are based in part on anatomic observations and in part on the results of injections with a solution of potassium ferrocyanide. In Guild's experiments this solution was injected into the cochlear duct in guinea pigs. Guild was able to demonstrate the presence of the dye (prussian blue) within the endolymphatic sac.

Doi [5] (1938) injected india ink into one of the semicircular canals in guinea pigs; half an hour later it was demonstrable in the sac.

In a series of experiments, I injected india ink into the great cistern in guinea pigs. The india ink was later found in the labyrinth, and in a few cases it was even demonstrable in the endolymphatic system and also within the sac. These observations, which will be published later, corroborate Guild's experiments.

The presence of lymph vessels in this particular section of the endolymphatic sac (the intermediary part), where the anatomic conditions for an absorption are the most favorable (Guild [1]), must be assumed to support the absorption theory, since in these observations the concern is with vessels conducting the fluid away from the endolymphatic sac. This view is also confirmed by the presence of the protein precipitations and the white blood cells. There are numerous white blood corpuscles in the lumen, in the perisaccular tissue and within the lymph vessels.

14. Boettcher, A.: Über Entwickelung und Bau des Gehörlabyrinthes nach Untersuchungen an Säugethieren, Dresden, E. Blockmann u. Sohn, 1869, pp. 1-203.

15. Hasse, C.: Bemerkungen über die Lymphbahnen des inneren Ohres, Arch. f. Ohrenh. **17**:188-194, 1881; Ztschr. f. Ohrenh. **10**:246, 1881.

It would, therefore, seem reasonable to assume that these white blood cells pass from the lumen of the sac into the blood vessel system via the lymph vessels, and it is highly probable that decomposed proteins follow the same route. The white blood cells are apparently at work in the decomposition of the highly molecular proteins of the endolymph, possibly as carriers of proteolytic enzymes.

## SUMMARY

Lymph vessels have been demonstrated in the connective tissue surrounding the endolymphatic sac. They are found in that part of the structure where the anatomic conditions for absorption are the most favorable. This observation supports the view that the endolymph is absorbed by the endolymphatic sac. Histological signs of precipitated protein and numerous white blood cells have been found in the lymph vessels.

A tentative explanation is advanced of the function of the wandering cells—the histiocytes—found within the lumen of the sac.

# BLASTOMYCOSIS OF THE EXTERNAL AUDITORY CANAL (BLASTOMYCES DERMATITIDIS)

A. P. KELLER Jr., M.D.
AND
T. O. W. MEISSNER, M.D.
CHAMBLEE, GA.

THE FIRST case of North American blastomycosis (Blastomyces dermatitidis) apparently was reported by Gilchrist [1] to the American Dermatological Association in June 1894. The name Gilchrist's disease has since been frequently applied to the condition caused by B. dermatitidis which usually occurs in the form of a chronic infection. The disease is characterized by the formation of granulomatous lesions associated often with intraepithelial, suppurative foci. Two workers, Jacobson [2] and Moore,[3] are largely responsible for the division of the disease into two categories: (1) a systemic type, which probably originates as a pulmonary infection and becomes dispersed throughout the body, usually proceeding to a fatal termination, and (2) a cutaneous type, which is the commoner form and is associated with verrucous, granulomatous lesions showing intradermal abscesses on microscopic section.

Clinically, North American blastomycosis is closely related to the paracoccidioidal (South American blastomycosis) type of infection found in the southern hemisphere. Except for the fact that the North American form reproduces primarily by single budding, while the South American form undergoes multiple budding, the two causative organisms are difficult to differentiate. However, the South American type responds to sulfonamide therapy in some cases, whereas the North American disease does not. Both the North and South American forms of this disease must be differentiated from chromoblastomycosis, the causative organism of which, however, is not a budding form and is identifiable by its peculiar pigmentation. Cryptococcosis, or European blastomycosis, may cause some confusion with the systemic form of the disease, but it rarely occurs in the cutaneous form, and it usually affects

From the Department of Otolaryngology, The Lawson Veterans Administration Hospital.

Sponsored by the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

1. Gilchrist, T. C., and Stokes, W. R.: Presence of an Oidium in Tissues of a Case of Pseudo-Lupus Vulgaris, Bull. Johns Hopkins Hosp. **7**:129, 1896.

2. Jacobson, H. P.: Fungous Diseases. A Clinico-Mycological Text, Springfield, Ill., Charles C Thomas, Publisher, 1932.

3. Moore, M.: Blastomycosis, Coccidioidal Granuloma and Paracoccidioidal Granuloma: Comparative Study of North American, South American, and European Organisms and Clinical Types, Arch. Dermat. & Syph. **38**:163-190 (Aug.) 1938.

the central nervous system. Likewise, the disease must be differentiated from tuberculosis and syphilis. Moore,[3] in discussing blastomycosis, listed the differential features found in the various types of this disease.

From the pathological standpoint the lesions observed in North American blastomycosis of the cutaneous type show several characteristics. There is a proliferation of the epithelium due to an acanthosis and increase in the size of the papillae. This is associated with numerous intraepithelial (or intradermal) abscesses throughout the diseased area. The involved areas develop granulomatous foci similar to those seen in the other chronic granulomas and, finally, the presence of the doubly refractile Blastomycetes themselves makes the pathological picture diagnostic of this disease. However, since the fungi may not be seen in every section, the very presence of a granulomatous type of lesion associated with intradermal abscesses should strongly suggest the possibility of blastomycosis. The lesion usually heals centrally while extending peripherally and thus on superficial examination might be mistaken for or confused with erythema multiforme.

The source of the infection is thought to be exogenous, and farmers seem to be infected more frequently than any other group of persons. The disease itself probably is not ordinarily transmitted from one human being to another, although cases have been recorded of direct inoculation, e. g., the case of a pathologist who infected himself through an abrasion during the performance of an autopsy on an infected patient.[4]

Concerning the treatment of the North American type of the disease, there is not much to be said. Surgical excision where practical may be the treatment of choice. Massive doses of the iodides by mouth or combined with intramuscular administration seem to be of benefit in the treatment of the cutaneous form. (Apparently the iodide has its effect on the granulation tissue, since in vitro it is not fungicidal to the Blastomyces in the dosages utilized.) Superficial radiation may be helpful. Unlike the paracoccidioidal type, which may respond to sulfonamide therapy, the North American form is not affected by sulfonamide treatment. Recent workers seem to have demonstrated that the antibiotics, penicillin and streptomycin,[5] may exert a deleterious effect on the patient infected with B. dermatitidis. This may be due to a sort of symbiotic response between the fungus and the mold broth. Since there is no known therapy which will stop the progression of the systemic form of this disease, it almost always proceeds to a fatal termination. Several new fungicidal agents are now being examined. These drugs, while often producing a good fungicidal effect in vitro, are frequently too toxic for use in vivo (viz., the polyethylene glycols and thiouracil-like and urethan-like drugs).

Examination of the literature covered by the *Quarterly Cumulative Index Medicus* for the 10 years 1940 to 1949, inclusive, failed to reveal a report of a case of B. dermatitidis involving only the external auditory canal.

4. Ormsby, O. S., and Montgomery, H.: Diseases of the Skin, ed. 7, Philadelphia, Lea & Febiger, 1948, p. 1,174.

5. Littman, M. L.; Wicker, E. H., and Warren, A. S.: Systemic North American Blastomycosis: Report of a Case with Cultural Studies of the Etiologic Agent and Observations on the Effect of Streptomycin and Penicillin in Vitro, Am. J. Path. **24**:339-365 (March) 1948.

## REPORT OF A CASE

On Jan. 20, 1949, a 34 year old white man reported to the Department of Otolaryngology of the Lawson Veterans Administration Hospital with the complaint of pain in the left ear, which had been discharging pus for four months. There was no history of ear disorders prior to the time of onset of the present illness. This patient had been admitted to the Lawson Veterans Administration Hospital in 1948 because of a lung abscess which had healed. The causation had not been determined even after several cultures of the sputum and bronchial washings were made. The patient had worked in a metal pipe shop for three years prior to this present admission, and he had done some farm work.

Otological examination on the day of admission to the clinic demonstrated a normal right ear. The external auditory canal of the left ear was filled with a foul-smelling purulent discharge. On removal of the discharge it was found that the left external auditory canal was nearly occluded by numerous small, friable, pearly-appearing, wartlike, granulomatous masses which prevented any view of the tympanum. From the clinical standpoint and from the appearance of the lesion, it was not possible to make a specific diagnosis.

Sections of tissue from the granulomatous masses were removed for microscopic examination. The first biopsy specimen did not reveal any Blastomycetes or demonstrate the presence of intradermal abscesses; subsequent biopsy specimens presented both. Blastomycetes were discovered in direct smears from the purulent material, and the organism, B. dermatitidis, was identified by cultural methods. (It is not in the scope of this paper to discuss methods and ways of isolating the organism, but Littman and his co-workers [5] described the technics in their paper reporting a systemic case.) A skin test was performed on the patient, using 0.1 cc. of a 1:10,000 dilution of a stock solution of Blastomyces cells. There resulted a violent reaction to the injected material, as indicated by edema and ulceration at the site of injection.

When the diagnosis of North American blastomycosis was established, the patient was treated by the peroral administration of a saturated solution of potassium iodide. The original dose of 5 drops three times a day was increased until the patient was taking 15 drops three times a day. The involved ear was treated locally with the removal of the granulomas by curettage and with the application to the diseased tissues of strong iodine powder (Sulzberger). The local treatment was carried out each day for two weeks and then twice a week for two months. After this treatment the condition of the left ear improved, and on April 2, 1949 the patient was discharged after approximately 10 weeks of therapy. He was seen again four months later, and the lesions on the external ear canal had healed. The tympanic membrane was retracted and did not move when inflated by the Politzer method. Roentgen visualization of the left mastoid bone showed sclerotic changes. The hearing in the left ear was decreased by 30 to 40 decibels, while a normal response was obtained on testing the right ear.

When the diagnosis of blastomycosis of the external auditory canal was established, it was thought that a review of the slides of pathological material prepared when the patient was hospitalized because of the lung abscess might show the presence of the fungus. Reexamination of the bronchial washings and of the pus from the abscess failed to reveal any Blastomycetes.

## SUMMARY

A case of North American blastomycosis (Blastomyces dermatitidis) of the external auditory canal is reported.

Examination of the literature for the past 10 years failed to reveal any other case of this disease which involved only the external auditory canal.

A method of treatment of the cutaneous infection with B. dermatitidis is presented which has proved successful in the present case and which is simple to pursue.

# SARCOMA OF THE LARYNX

JOSEPH LACHMANN, M.D.
JERUSALEM, ISRAEL

SARCOMA of the larynx is very rare. Ballenger [1] stated that many neoplasms of the larynx formerly thought to be sarcoma are considered of epithelial origin at the present, agreeing in this opinion with Ewing.[2] This error may be intelligible when one considers Ewing's statement based on Butler's observations that sarcoma arises in much the same situations as the epithelial tumor and that in its early stages sarcoma resembles this tumor. The Jacksons [3] also stress that "the cellular structure of the carcinomas closely simulates sarcomatous histology," and Eggston [3a] writes: "In my experience the histologic diagnosis of sarcoma is not as well defined as in the epithelial tumors, and so there may be some sarcomas that belong to the epithelial group."

The early statistics in the German literature by Sendziak,[4] Bergeat,[5] Simon [6] and Spiess [7] showed the rarity of sarcoma of the larynx, and Kahler,[8] who saw only two cases of sarcoma in 27 years, collected from the literature until 1929 not more than 183 cases of this tumor.

The statistics in the American literature confirm these observations. Tucker [9] saw only one sarcoma in 200 cases of malignant lesions of the larynx, and Figi [10] saw four sarcomas among 717 cases during 23 years at the Mayo Clinic. During 31 years at the same clinic, Havens and Parkhill [11] collected, in addition to Figi's

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From the Ear, Nose and Throat Department of the Rothschild-Hadassah-University Hospital and the Anatomo-Pathological Institute of the Hebrew University.

1. Ballenger, W. S., and Ballenger, H. C.: Diseases of the Nose, Throat and Ear: Medical and Surgical, ed. 8, Philadelphia, Lea & Febiger, 1943, p. 518.

2. Ewing, J.: Neoplastic Diseases: A Treatise on Tumors, ed. 4, Philadelphia, W. B. Saunders Company, 1940.

3. Jackson, C., and Jackson, C. L.: Diseases and Injuries of the Larynx: A Textbook for Students and Practitioners, ed. 2, New York, The Macmillan Company, 1942.

3a. Eggston, A. A., in Kernan, D. J.: Surgery of the Nose and Throat, New York, Thos. Nelson & Sons, 1942, p. 646.

4. Sendziak, cited by Jaffe, Leicher and Pfeiffer, in Blumfeld, F., and Jaffé, R.: Pathologie der oberen Luft- und Speisewege, Leipzig, Curt Kabitzsch, 1931.

5. Bergeat, H.: Monatschr. f. Ohrenh. **31**:193, 1897.

6. Simon, H.: Die Sarkome, in Küttner, H.: Neue deutsche Chirurgie, Stuttgart, Ferdinand Enke, 1928, vol. 43.

7 Spiess: Ztschr. f. Laryng., Rhin. **16**:21, 1927.

8. Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde, Berlin, Springer-Verlag, 1927.

9 Tucker, G.: Cancer of Larynx: Observation in Two Hundred Consecutive Cases, Arch. Otolaryng. **21**:1 (Jan.) 1935.

10. Figi, F. A.: Sarcoma of Larynx, Arch. Otolaryng. **18**:21 (July) 1933.

11. Havens, F. Z., and Parkhill, E. M.: Tumors of the Larynx Other Than Squamous Cell Epithelioma, Arch. Otolaryng. **34**:1113 (Dec.) 1941.

four cases, seven new cases and 15 cases from the English literature. Therefore, Ewing's statistics that sarcomas comprise 11 per cent of malignant growths of the larynx are apparently too high, and Clerf's [12] statement that the ratio is 1 : 92 is probably more correct.

The statistics of Havens and Parkhill preceded reports by the following authors:

Baldenweck and Leroux-Robert [13] observed a reticulosarcoma of the larynx in a woman aged 76. Gonzales Loza and associates [14] reported a fibrosarcoma in a woman aged 28. Rigby and Holinger [15] observed a fibrosarcoma of the larynx in a newborn infant. Foster [16] reported a case of fibrosarcoma in a man aged 31. Ferguson [17] reported a successful operation in two cases of fibrosarcoma in men 69 and 65 years old respectively. Glick [18] saw an unusual neoplasm (rhabdomyomyxosarcoma) in the larynx of a child. Clerf,[12] who gave a review of his observations at the Jefferson Medical College Hospital, in Philadelphia, had observed since 1930 eight cases of sarcoma and 740 cases of carcinoma of the larynx, a ratio of 1 : 92.

Considering the rarity of sarcoma of the larynx, it seems justified to report two cases of this condition observed at the Rothschild-Hadassah-University Hospital.

## REPORT OF TWO CASES

Case 1.—A male patient 52 years of age had been suffering for one year from hoarseness when he came to see me on Aug. 27, 1940. Mirror laryngoscopy showed a big subglottic tumor, the origin of which was the anterior wall of the larynx. The red tumor, which seemed to be of solid consistency, filled more than half the lumen of the larynx (fig. 1). The vocal cords and the ventricular bands were free; the motility of the cords was normal. A biopsy gave the microscopic diagnosis of hyperkeratosis of the epithelium with no signs of malignity. Three endolaryngeal biopsies performed during the next four months gave the same results. The patient did not agree to removal of the tumor by direct laryngoscopy. Then he was not seen for six months. When he appeared again on June 8, 1941, he reported that in the previous two months he had been suffering from such difficulties in respiration, which had become gradually worse, that he felt himself in danger of suffocation. The mirror laryngoscopy disclosed that the whole larynx was almost filled by the tumor (fig. 2).

The patient refused operation (tracheotomy and laryngofissure), but the next day he was brought to the hospital nearly suffocating, completely cyanotic and unconscious. Without anesthesia, an inferior tracheotomy *d'urgence* was made immediately, and 30 minutes after the intervention the patient regained consciousness and his normal skin color.

Four weeks after the tracheotomy thyrotomy was performed. It became evident that the whole larynx from the basis of the epiglottis down to the cricoid region was filled by a reddish solid tumor. The whole tumor could be removed by loosening the whole mucous membrane from the base of the epiglottis to the cricoid region without touching the cartilage. In order to preserve the lumen of the larynx and to avoid strictures, the larynx was not filled with gauze but with a specially built condom-fingerstall, which, after introduction into the lumen of the larynx, could be inflated through a rubber tube that remained outside the larynx (fig. 3).

12. Clerf, L. H.: Sarcoma of Larynx: Report of Eight Cases, Arch. Otolaryng. **44**:517 (Nov.) 1946.

13. Baldenweck, L., and Leroux-Robert, J.: Ann. d'oto-laryng., 1942, p. 94.

14. Gonzales Loza, M.; Imhoff, D., and Fernandez Rodriguez: Rev. otorrinolaring. d. litoral **2**:458, 1943.

15. Rigby, R. G., and Holinger, P. H.: Fibrosarcoma of Larynx in Infant, Arch. Otolaryng. **37**:425 (March) 1943.

16. Foster, J. H.: Ann. Otol., Rhin. & Laryng. **53**:764, 1944.

17. Ferguson, G. B.: Sarcoma of Larynx, Arch. Otolaryng. **38**:265 (Sept.) 1943.

18. Glick, H. N.: Ann. Otol., Rhin. & Laryng. **53**:699, 1944.

*Anatomico-Pathological Report* (Anatomo-Pathological Institute of the Hebrew University and Rothschild-Hadassah-University Hospital, Professor Franco, Director; microscopic examination 899/41).—"Five fragments of tumor tissue were examined histologically. One of them is composed predominantly of compact collagen tissue, which is composed of interlacing fibers containing only sparse nuclei of fibrocytes in regular distribution. In the vicinity of this 'sclerotic' area there is a more cellular tissue, which displays a similar architecture. The nuclei are fairly uniform in appearance, without mitotic figures.

In all other areas the tumor cells show an extremely pleomorphic character (fig. 4). They lie mostly in rows, but the nuclei are of different volume and size; the amount of chromatin

Fig. 1.—Sarcoma of the larynx. Mirror appearance on the patient's first visit.

Fig. 2.—Sarcoma of the larynx. Mirror appearance the day before the operation.

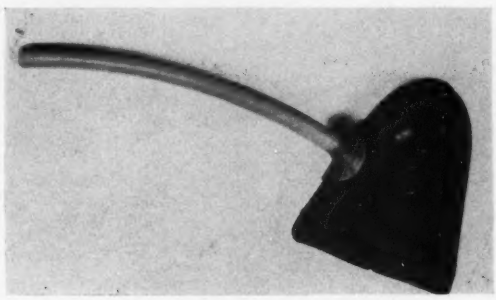

Fig. 3.—Condom-fingerstall with rubber tube.

varies considerably. There are scattered mitotic figures and a considerable number of giant cells containing a single deformed nucleus or three to four small nuclei. In these areas there is marked increase in capillaries; collagen fibers in some places still form a fibroid pattern, while in others they have decreased in amount, forming a discrete reticulum.

The tissue fragment described first, which includes wide sclerotic areas, is covered with stratified noncornifying squamous epithelium. It is, in some places, considerably thicker than the usual covering of vocal cords, the germinating layer having especially increased, displaying a moderate widening of intercellular bridges. The subepithelial layer is infiltrated by a small number of segmented granulocytes (polymorphonuclear leukocytes) and small round cells."

*Histological Diagnosis.*—The diagnosis was polymorphocellular sarcoma, arising from fibrosarcoma.

Comment: The areas of sarcoma are mainly in the depth of the lesion, while the more superficial layers show transition from fibroma and sclerosis to fibrosarcoma, being covered by hypertrophic epithelium. The varying aspects of the lesion may explain the result of a histological examination of the previous biopsies, which failed to reveal the malignant process.

*Subsequent Course.*—The healing process was uneventful. Two weeks after the thyrotomy the tracheal cannula and the condom-fingerstall were removed. Respiration through the larynx was undisturbed and completely free. Mirror laryngoscopy showed good mobility of the arytenoid cartilages, good endothelization of the larynx and already the beginning of the formation of new strings on the site of the former vocal cords. The patient received radium treatment, 7,650 r in forty sittings.

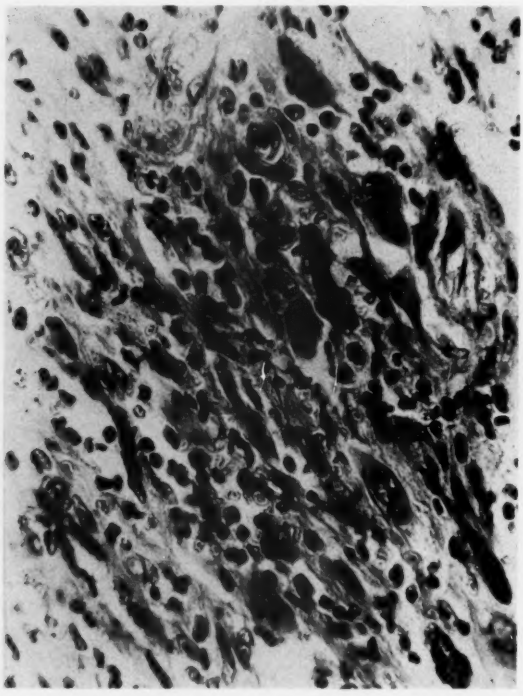

Fig. 4.—Polymorphocellular sarcoma of the larynx (magnification 440).

When the patient was last seen on April 15, 1947, six years after the operation and about five and one-half years after the radium treatment, there was no recurrence of the tumor. The mirror laryngoscopy shows free respiration, normal mobility of the arytenoid cartilages and new strings on the site of the ventricular bands and the vocal cords, which function in the same way as the former cords, thereby enabling the patient to speak with a hoarse, fairly loud voice.

Case 2.—E. M., a male patient aged 63, had been suffering from hoarseness and coughing for 12 months. He received local treatment in his native country without any effect. A biopsy of the larynx showed a malignant tumor; no specific description of the slide was available. Mirror laryngoscopy revealed a tumor of the left vocal cord, extending from the anterior commissure to the arytenoid region (fig. 5). There was no movement of the left vocal cord or anything abnormal on the right side of the larynx. Tomography (fig. 6) confirmed the observation that the tumor was on the left side only. It extended to the cricoid region.

On July 2, 1945, after an inferior tracheotomy, a subtotal hemilaryngectomy (left) was performed with local anesthesia. A small part of the mucous membrane and cartilage of the anterior part of the right side were excised. The operation was concluded with tamponade, the use of sutures and introduction of an esophageal tube.

Fig. 5.—Lymphosarcoma of the larynx. Mirror appearance on patient's first visit.

Fig. 6.—Tomography, showing extension of the tumor (case 2).

*Anatomicopathological Report.*—"The tumor is composed of round cells of fairly uniform character [fig. 7]. The nuclei are slightly larger than those of lymphocytes and contain one to three discrete nucleoli. The cytoplasm is scarcely visible; in some cells it is excentric and palely basophilic without granules. Only a few scattered mitotic figures were observed. The stroma is composed of an irregular reticulum and some more compact collagen trabeculae,

which include congested blood vessels. The specimen of the right larynx shows no sign of any tumor-like tissue, and there are no signs of tumor in the tissues underneath the tumor."

*Histological Diagnosis.*—Lymphosarcoma.

*Subsequent Course.*—The healing process was satisfactory, and the esophageal tube was removed after four days. The patient was feeling well and got up for a walk six days after the operation. On July 10, at 10:30 p. m. (the ninth day after operation), sudden death occurred when the patient, after having walked in the corridor of the hospital, returned to bed.

*Postmortem Report.*—Posthemilaryngectomy (left) status; embolism of the pulmonary artery due to thrombosis of the left femoral vein. In the liver, spleen, mesenteric and mediastinal lymph glands and in the esophageal region there were no signs of metastasis.

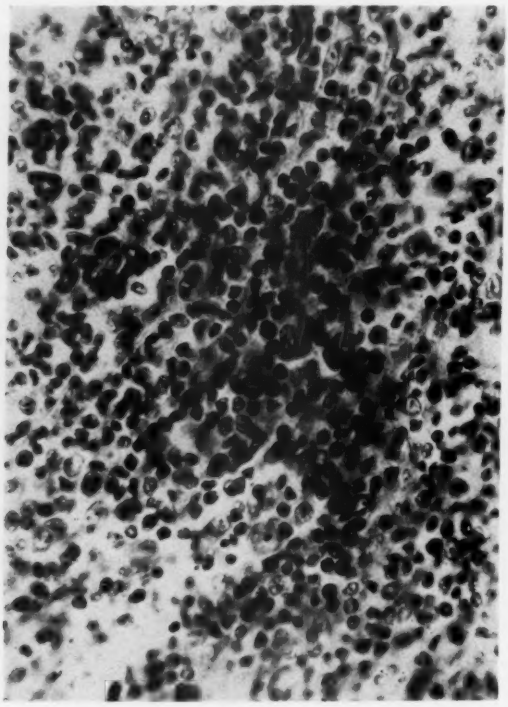

Fig. 7.—Lymphosarcoma of the larynx (magnification 440).

## COMMENT

Sarcoma of the larynx is rare. The rate of occurrence of sarcoma as compared to that of malignant growths of the larynx given by various authors varies from 11 per cent (Ewing) to 0.5 per cent (Tucker). In the radium department of our hospital, 190 malignant tumors of the larynx were treated in 13 years, two of which were sarcomas. Accordingly, I can give a ratio of 1:95, in agreement with that of Clerf.

It is commonly accepted that sarcoma of the larynx is a disease of adult life and is commoner in men, as are malignant diseases of the larynx on the whole.

The Jacksons' statistics show that of 688 cases of malignant diseases of the larynx, 635, or 92.3 per cent, occurred in men and 53, or 7.7 per cent, in women, whereas cancer of the hypopharynx and upper orifice of the esophagus is about seven times more frequent in women than in men. In this respect, our two cases of laryngeal sarcoma in men of advanced age confirm the common experience.

According to Ewing and to Kaufmann [19] many histological varieties are described, most frequently spindle cell types (sometimes polymorphocellular) or roundish or knotty in shape, of solid consistency, generally of uneven surface and slow growth, with metastasis usually very late or not at all to the lymph glands. Other forms are round cell sarcomas or alveolar sarcomas, which are inclined to decay and to infiltrate into laryngeal structures and the lymph glands of the neck. Exceptional are the case of Baldenweck and Leroux-Robert (reticulosarcoma in a woman aged 28) and our case of lymphosarcoma. Ewing stresses also the rarity of lymphosarcoma, which was described first by Koshier and Stoerk. Of our two cases, the first one represents the commoner form of sarcoma, except for the site of origin, which was unusual. The second one was exceptional as far as the histological structure, as well as the localization, the shape and the clinical behavior, was concerned. Ewing states that sarcoma commonly involves the vocal cords and the epiglottis. In our first case the first site of appearance was the anterior wall of the larynx below the cordal level. According to Jackson, only in a small percentage of his cases has the growth originated on the anterior wall of the larynx above or below the cordal level; this site is very rare, as compared to that of the cord.

The tumor in the first case was single, not pedunculated, firm, not ulcerated, avascular and did not metastasize. It filled more than half the lumen; after four biopsies it grew very slowly toward the vocal cords, ventricular bands and base of the epiglottis until it filled the whole lumen of the larynx. As neither direct laryngoscopy nor tomography was performed, it was impossible to know anything about the downward extension of the tumor. The various biopsies performed in this case did not reveal the nature of the tumor. This situation may occur often, as Fergusson also stresses in his report of two cases. Although in one of his cases the biopsy was done in direct laryngoscopy, the diagnosis was fibroma at the first biopsy and not clear at the second. In both his cases only the examination of the whole tumor after thyrotomy gave the diagnosis, fibrosarcoma.

Clerf [12] also states that the pedunculated form may be confused with inflamed fibroma and that biopsy is often not satisfactory, as the overlying mucosa may be normal. Increasing dyspnea and absence of ulceration should suggest sarcoma; therefore repeated biopsies may be necessary. Clerf was fortunate to have in three cases a positive diagnosis from the first biopsy, but in our first case even four biopsies did not indicate the right diagnosis. If it had not been for the growth of the tumor, which nearly suffocated the patient, thereby forcing us to perform tracheotomy and influencing the patient to agree to the thyrotomy, we would never have arrived at the right diagnosis.

I most agree with the many authors who stress that it is not always possible to clarify every tumor by histological examination and that there often are tumors which show a partly benign structure and a partly malignant one. The explanation

19 Kaufmann, E.: Lehrbuch der speziellen pathologischen Anatomie für Studierende und Ärzte, ed. 9 and 10, Berlin, W. de Gruyter & Co., 1931, vol. 1, p. 291.

for the failure of the histological diagnosis in our first case is given by the pathologist: "The areas of sarcoma are mainly in the depth of the lesion, while the more superficial layers show transition from fibroma and sclerosis to fibrosarcoma, being covered by hypertrophic epithelium."

In our second case the biopsy made outside of Israel gave the diagnosis of malignant tumor without specification. The slides were not available. We diagnosed carcinoma and proposed to the patient an operation or roentgen-ray treatment. The patient chose the operation. We therefore performed a hemilaryngectomy. The histological examination gave the surprising diagnosis of lymphosarcoma. That we suspected carcinoma is, according to Kaufmann, understandable, for neither the site of the origin of the tumor nor its appearance would lead one to suspect lymphosarcoma, which originates often from the pharynx and infiltrates the lymph glands of the neck. Kaufmann stresses the fact that lymphosarcoma produces solid pale infiltrations. In our case we could only state that a tumor existed, probably a malignant one, but neither the localization nor the macroscopic appearance corresponded to the signs of lymphosarcoma described by Kaufmann.

The symptoms of sarcoma are those of every malignant tumor of the larynx; the first are hoarseness and coughing, later followed by sensation of suffocation if the tumor is big enough to bar the airway. The patient complains of pain only if there is extension of the tumor outside the larynx to the pharynx, infiltration of the neighboring tissues, especially the region of the superior laryngeal nerves, or ulceration or decay with secondary infection. In our first case hoarseness preceded near suffocation, owing to the filling up of the whole larynx by the tumor. In the second case there was only hoarseness and coughing.

As to the therapy, if we had known from the biopsy that the diagnosis was lymphosarcoma we surely would have referred the patient to our radium institute for irradiation. In agreement with Clerf, we think that irradiation should be the treatment of choice in cases of lymphosarcoma. However, experience with lymphosarcoma of the larynx is limited. If one could remove the whole tumor in healthy tissue it seems justified to perform a hemilaryngectomy, even in cases of lymphosarcoma without metastases and swelling of the regional glands. In our case the postmortem examination showed that neither in the mediastinum nor in the hypopharyngeal or esophageal region were there signs of tumor metastases. For lymphosarcoma this is very noteworthy, because, according to Kaufmann and to Jaffe and associates,[20] very often there are early metastases within the lymph glands in lymphosarcoma and round cell sarcoma, whereas in the other forms (fibrosarcoma) such metastases occur very seldom. The death of the patient with lymphosarcoma was not due to the operation or to the disease of the larynx.

In our first case the success of the operation and the after-treatment (also the use of the condom-fingerstall) justifies our procedure fully. According to Figi,[10] "The treatment of sarcoma of the larynx depends on its size, situation and activity. Since many of these tumors are pedunculated and show less tendency to infiltrate the laryngeal structures and metastasize later than do carcinomas of the larynx, they may remain operable for a considerably longer period. . . . Thyrotomy is especially useful in the treatment of sarcoma of the larynx . . . ."

20. Jaffe, Leicher and Pfeiffer, in Blumenfeld, F., and Jaffé, R.: Pathologie der oberen Luft- und Speisewege, Leipzig, Curt Kabitzsch, 1931, pt. 2, p. 652.

According to our limited experience, we can agree with the opinion of Figi and summarize the situation as follows: It is advisable to perform thyrotomy when there is a tumor of the larynx of considerable size which originates from the anterior or posterior wall of the larynx or from the vocal cords if the tumor shows no signs of ulceration, is not vasculated and recurs after an endolaryngeal operation after a comparatively short period. We must then suspect, at least, or make a diagnosis of sarcoma even when repeated biopsies do not give positive results. Since in our first case there was neither infiltration into the laryngeal structures nor metastasis, we succeeded in saving the patient; yet we believe that one must not wait until signs of suffocation appear before performing a thyrotomy.

By this method of treatment, we can ameliorate the prognosis of sarcoma of the larynx, which most of the German authors declared to be very bad. Perhaps this opinion is based on cases of growths which were erroneously described as sarcoma and which actually may have been tumors of epithelial character. Perhaps the experiences were based on growths which were not diagnosed in time as sarcoma but as fibroma, and the patient came for radical treatment only after extension into the laryngeal structures or into the pharynx and even metastasis to the lymph glands of the neck. Successful treatment can be expected only as long as the tumor remains intrinsic in location. The reports of Ferguson and Clerf show, as in our first case, that the majority of cases of sarcoma of the larynx in which the growth did not become extrinsic or metastatic before the operation or the radiation treatment remained free from recurrences from five to 10 years.

In our first case there has been no recurrence yet, six years after the operation. Our second case (lymphosarcoma) cannot be considered with regard to the prognosis, for the patient died of an embolism of the pulmonary artery due to thrombosis of the femoral vein. In this case, too, the prognosis was not bad because the lymphosarcoma was not of a very malignant type. It was limited to the inner larynx (intrinsic), had no tendency to ulcerate or to decay and did not metastasize to the lymph glands of the neck, as lymphosarcoma usually do.

SUMMARY

Two cases of sarcoma of the larynx are reported. The first case was that of a polymorphocellular sarcoma of rare origin (the anterior wall of the larynx below the cordal level), the diagnosis of which could not be clarified by four biopsies but only after thyrotomy and removal of the whole tumor.

The second was a rare case of lymphosarcoma originating from the vocal cord, an unusual condition for this kind of tumor. It did not have the appearance of a lymphosarcoma and did not infiltrate into the laryngeal structures, nor did it metastasize to the lymph glands of the neck but remained intrinsic.

The first patient is free from recurrence six years after operation. The second patient died, after a successful operation, from embolism of the pulmonary artery due to thrombosis of the femoral vein. The incidence, symptoms, diagnosis, treatment and prognosis of sarcoma of the larynx are discussed.

Ramban Road (The Windmill).

Dr. Ungar, pathologist at the Anatomo-Pathological Institute of the Hebrew University and the Rothschild-Hadassah-University Hospital (Professor Franco, director), placed the histological reports and the photomicrographs at my disposal.

# ACTION OF DIMENHYDRINATE (DRAMAMINE) AND OTHER DRUGS ON VESTIBULAR FUNCTION

LEONARD B. GUTNER, M.D.
WILBUR J. GOULD, M.D.
AND
ROBERT C. BATTERMAN, M.D.
NEW YORK

DIMENHYDRINATE (2-[benzohydryloxy]-N, N-dimethylethylamine 8-chlorotheophyllinate) (dramamine) has recently been introduced for the prevention and treatment of motion sickness. It has been employed successfully in seasickness [1] and airsickness.[2] Several reports have appeared attesting to its value in radiation sickness,[3] nausea and vomiting of pregnancy,[4] Ménière's syndrome,[5] vestibular reactions following labyrinthine operations [6] and in vertigo of vestibular origin.[7] Although the drug by weight contains 54 per cent of diphenhydramine and 46 per cent of 8-chlorotheophylline, it is considered to be a specific chemical compound rather than a mixture of its two components (fig. 1).

## METHOD

The action of dimenhydrinate on vestibular function was investigated by means of the cold microcaloric test [8] and galvanic stimulation of the mastoid area.[9] The former method depends on the integrity of the peripheral end organ in the labyrinth. By means of 2 cc. of ice water (water with floating ice) introduced by a syringe into the external auditory canal, a nystagmic movement of the eyeballs is produced which can be measured readily in terms of onset and duration. The ratio of the onset of nystagmus to its duration was found to be a reliable index

From the Department of Therapeutics, New York University-Bellevue Medical Center, and the Ear, Nose and Throat Services of Lenox Hill and Bellevue Hospitals.

1. Gay, L. N., and Carliner, P. E.: The Prevention and Treatment of Motion Sickness in Seasickness, Science **109**:359 (April 8) 1949.

2. Strickland, B. A., Jr., and Hohn, G. L.: The Effectiveness of Dramamine in the Prevention of Airsickness, Science **109**:359 (April 8) 1949.

3. Beeler, J. W.; Jilbisch, J. H., and Popp, W. C.: A New Drug in the Treatment of Radiation Sickness, Proc. Staff Meet., Mayo Clinic **24**:477 (Sept. 14) 1949.

4. Carliner, P. E.; Radman, H. M., and Gay, L. N.: Preliminary Report, Treatment of Nausea and Vomiting of Pregnancy with Dramamine, Science **110**:215 (Aug. 26) 1949.

5. Ménière's Syndrome, Queries and Minor Notes, J. A. M. A. **141**:500 (Oct. 15) 1949.

6. Campbell, E. H.: The Effectiveness of Dramamine in Relieving the Vestibular Reactions Following the Labyrinthine Fenestration Operation, Laryngoscope **59**:1261 (Nov.) 1949.

7. Witzeman, L. A.: A New Treatment for Vertigo, Eye, Ear, Nose and Throat Monthly **28**:272 (June) 1949.

8. Atkinson, M.: A Single Quantitative Method of Testing Vestibular Function, Arch. Otolaryng. **30**:916 (Dec.) 1939. McNally, W. J.: The Physiology of the Vestibular Mechanism in Relation to Vertigo, Ann. Otol., Rhin. & Laryng. **56**:514 (Sept.) 1947.

9. Fowler, E. P.: Medicine of the Ear, in Nelson Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1948, p. 439.

of basal sensitivity of the patient's labyrinth. The cold microcaloric method differs from other caloric studies in that the test can be performed repeatedly within a designated period without disturbance or discomfort to the subject. The same ear of the subject was used throughout. None of the subjects presented any otoscopic or other evidence of aural or labyrinthine abnormality. In actual performance of the test the subject was seated with the head in the maximal position, that is with the head inclined laterally so that the ear to be tested was uppermost. Immediately after the onset of the nystagmus was recorded, the head was returned to the upright position and the external auditory canal emptied of ice water. The nystagmus was observed continuously until it subsided.

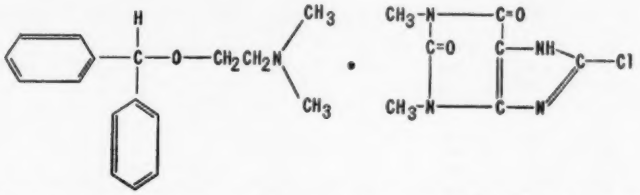


Fig. 1.—Dimenhydrinate (2-[benzohydryloxy]-N, N-dimethylethylamine 8-chlorotheophyllinate.)

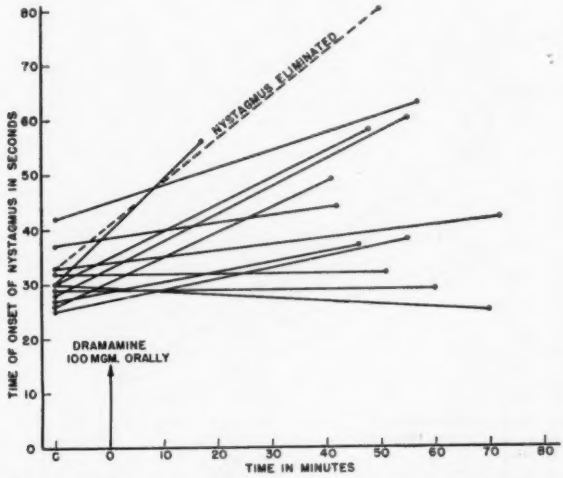


Fig. 2.—Effect of dramamine in the cold microcaloric method on the onset of nystagmus.

The galvanic stimulation of the mastoid area is dependent on the integrity of the vestibular nerve tract and brain centers. The test consists in applying the moistened anode electrode to the skin of the mastoid area while the subject holds the moistened cathode in the contralateral hand. The subject is balanced on a tilt board in the standing position. As the galvanic current is gradually increased through a Burdick stimulator, the subject will tilt to the side away from the mastoid electrode. The amount of current in milliamperes required to produce this response is the end point.

Thirty-three studies were performed on 19 subjects. After a control period consisting of three determinations of the cold microcaloric test at intervals of five minutes and a single base line determination of milliamperes required for tilting in those subjects studied also by the galvanic stimulation, a drug was administered and the tests repeated at intervals of approximately 20 minutes. All drugs in this phase of the investigation were administered orally. In

addition to dimenhydrinate which was studied in 100 mg. doses, the effects of 50 mg. of diphenhydramine hydrochloride, 100 mg. of 8-chlorotheophylline, 500 mg. of aminophylline, 0.6 mg. of scopolamine hydrobromide (hyoscine hydrobromide) and 100 mg. of seconal sodium were investigated.

TABLE 1.—*Influence of Dimenhydrinate (100 mg. Administered Orally) on Vestibular Function, as Measured by Cold Microcaloric Method*

| | | Time of Onset of Nystagmus in Seconds | | | Duration of Nystagmus in Seconds | | | Ratio of Time of Onset and Duration of Nystagmus | |
|---|---|---|---|---|---|---|---|---|---|
| Subject | Age, Yr. | Control * | Dimenhydrinate | Per Cent of Change | Control * | Dimenhydrinate | Per Cent of Change | Control | Dimenhydrinate |
| G. G..... | 35 | 30 | 56 | +87 | 148 | 87 | —41 | 1:4.9 | 1:1.6 |
| D. M..... | 26 | 33 | 42 | +27 | 102 | 80 | —50 | 1:4.9 | 1:2.0 |
| H. W..... | 41 | 25 | 38 | +52 | 154 | 30 | —81 | 1:6.2 | 1:0.8 |
| J. H..... | 15 | 33 | Nystagmus eliminated | .... | 151 | Nystagmus eliminated | .... | 1:4.6 | ..... |
| J. A..... | 61 | 26 | 49 | +88 | 142 | 118 | —17 | 1:5.5 | 1:2.4 |
| P. C..... | 49 | 28 | 60 | +114 | 150 | 63 | —58 | 1:5.4 | 1:1.1 |
| R. S..... | 29 | 42 | 63 | +50 | 148 | 45 | —69 | 1:3.4 | 1:0.7 |
| W. C..... | 50 | 30 | 25 | —17 | 120 | 82 | —32 | 1:4.0 | 1:2.8 |
| W. R..... | 63 | 30 | 58 | +93 | 108 | 32 | —70 | 1:3.6 | 1:0.6 |
| W. M..... | 45 | 37 | 44 | +19 | 119 | 55 | —54 | 1:3.2 | 1:1.4 |
| I. N..... | 47 | 29 | 29 | 0 | 122 | 74 | —39 | 1:4.2 | 1:2.2 |
| M. K..... | 69 | 32 | 32 | 0 | 111 | 65 | —41 | 1:3.5 | 1:2.0 |
| E. A..... | 60 | 27 | 37 | +37 | 108 | 55 | —49 | 1:4.0 | 1:1.5 |

* Average of three determinations.

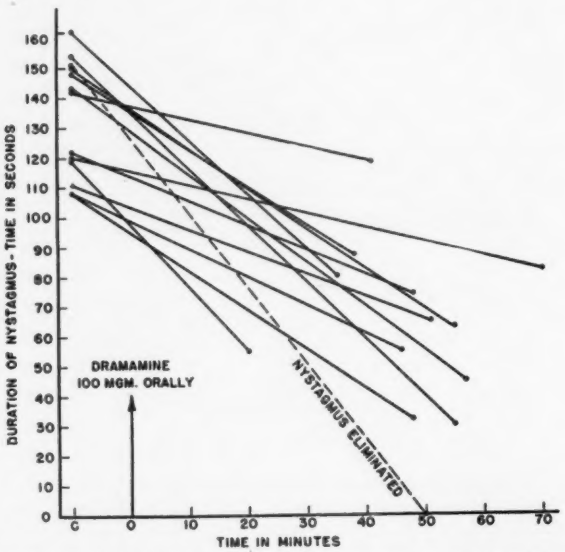


Fig. 3.—Effect of dramamine in the cold microcaloric method on the duration of nystagmus.

## RESULTS

Dimenhydrinate was the only drug of those studied which consistently depressed vestibular function. In the 13 subjects tested according to the microcaloric method, the time of onset of the nystagmus was prolonged in nine (table 1, fig. 2). This prolongation varied from 19 to 114 per cent (average 63 per cent)

of the control readings. In one subject, the drug completely prevented the occurrence of nystagmus. Two subjects presented no change, while in only one subject was there any decrease in time of onset. Also, there was a pronounced decrease in the duration of the nystagmus. This decrease was noted in every subject except the one who had complete elimination of the nystagmus. The duration was decreased from 17 to 81 per cent, or an average of approximately 50 per cent (fig. 3). The over-all depression of the labyrinth can be expressed best by the ratio of time of onset of nystagmus to its duration. In every subject the

TABLE 2.—*Influence of Dimenhydrinate (100 mg. Administered Orally) on Vestibular Function, as Measured by Galvanic Stimulation*

| Subject | Age, Yr. | Milliamperes Required for Tilting | | |
|---|---|---|---|---|
| | | Control | After Use of Dimenhydrinate | Per Cent of Change |
| W. R. | 63 | 3 | 8 | +167 |
| W. M. | 45 | 4 | 8 | +100 |
| I. N. | 47 | 2 | 3.5 | + 75 |
| M. K. | 69 | 2 | 5 | +150 |
| E. A. | 60 | 3 | 5 | + 66.6 |

TABLE 3.—*Influence of Various Drugs Administered Orally on Vestibular Function, as Measured by Cold Microcaloric Method*

| Drug | Subject | Age, Yr. | Time of Onset of Nystagmus in Seconds | | Per Cent of Change | Duration of Nystagmus in Seconds | | Per Cent of Change | Ratio of Time of Onset to Duration of Nystagmus | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Control * | After Drug | | Control * | After Drug | | Control | After Drug |
| Diphenhydramine, 50 mg. | H. V. | 41 | 29 | 29 | 0 | 154 | 134 | —13 | 1:5.3 | 1:4.8 |
| | J. H. | 15 | 29 | 29 | 0 | 153 | 153 | 0 | 1:5.3 | 1:5.3 |
| | O. E. | 50 | 20 | 20 | 0 | 100 | 100 | 0 | 1:5.0 | 1:5.0 |
| | M. M. | 50 | 27 | 27 | 0 | 102 | 146 | +43 | 1:3.8 | 1:4.7 |
| | W. M. | 45 | 33 | 33 | 0 | 111 | 111 | 0 | 1:3.4 | 1:3.4 |
| 8-Chlorotheophylline, 100 mg. | O. P. | 61 | 28 | 28 | 0 | 100 | 100 | 0 | 1:3.6 | 1:3.6 |
| | W. M. | 45 | 30 | 24 | —20 | 100 | 101 | — 8 | 1:3.7 | 1:4.3 |
| | M. K. | 69 | 31 | 31 | 0 | 110 | 120 | + 8 | 1:3.6 | 1:3.6 |
| Aminophylline, 500 mg. | W. M. | 45 | 35 | 35 | 0 | 120 | 120 | 0 | 1:3.4 | 1:3.4 |
| | M. W. | 65 | 35 | 35 | 0 | 125 | 125 | 0 | 1:3.6 | 1:3.6 |
| Secobarbital sodium, 100 mg. | P. C. | 49 | 33 | 33 | 0 | 136 | 136 | 0 | 1:4.1 | 1:4.1 |
| | R. S. | 29 | 36 | 23 | —36 | 153 | 136 | —11 | 1:4.3 | 1:6.3 |
| | O. E. | 50 | 19 | 19 | 0 | 97 | 97 | 0 | 1:5.1 | 1:5.1 |
| | M. M. | 50 | 24 | 34 | +42 | 95 | 95 | 0 | 1:4.0 | 1:3.1 |
| | W. M. | 45 | 31 | 31 | 0 | 105 | 105 | 0 | 1:3.4 | 1:3.1 |

* Average of three determinations.

ratio was materially lowered. The control ratios ranged from 1:3.2 to 1:6.2, with an average of 1:4.4. After use of the drug the ratios ranged from zero to 1:2.8, with an average of 1:1.4. Thus there was approximately on the average a 60 per cent decrease in the function of the labyrinth. With galvanic stimulation the results were similar. In all five subjects, after the use of the drug, there was a decided increase in the amount of galvanic current necessary to produce the same degree of tilting of the body as the control stimulation. This increase in galvanic current varied from 66.6 to 167 per cent, with an average of approximately 100 per cent (table 2).

When diphenhydramine, aminophylline, 8-chlorotheophylline and secobarbital sodium were administered orally they produced no significant alterations in ves-

tibular function, as measured by the microcaloric or galvanic stimulation methods (table 3, figs. 4 and 5).

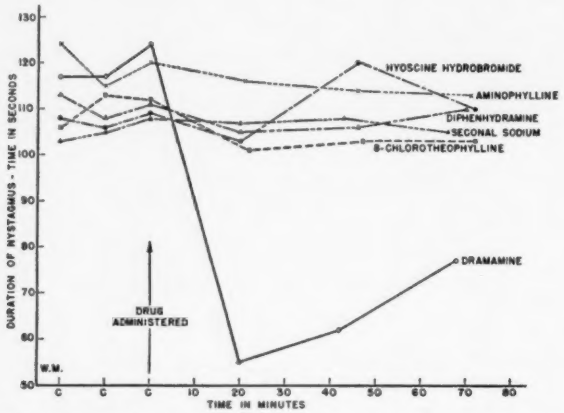


Fig. 4.—Effect on the duration of nystagmus, as measured by the cold microcaloric method.

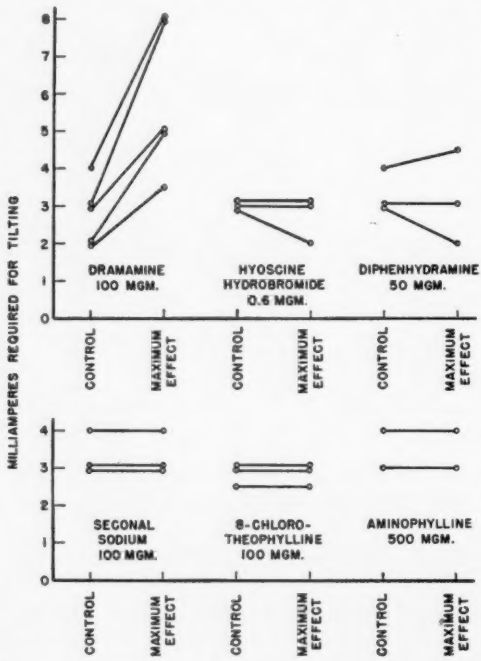


Fig. 5.—Effect on the vestibular function, as measured by galvanic stimulation.

An unusual finding was the apparent stimulation of vestibular function by scopolamine hydrobromide. Although the time of onset of nystagmus was not notably altered, there occurred in four out of five subjects an increase in the dura-

tion of the nystagmus (table 4). This occurrence increased the ratio of the time of onset of nystagmus to duration from an average control of 1:3.9 to 1:4.8, or an increase of approximately 23 per cent. There was no significant change in the galvanic test (fig. 5) indicating that any increased sensitivity of vestibular function was primarily related to an increased responsiveness of the labyrinth itself.

Since the foregoing results indicate that neither one of the components of dimenhydrinate (diphenhydramine or 8-chlorotheophylline), when administered orally and by itself, significantly affected vestibular function, it became important

TABLE 4.—*Influence of Scopolamine Hydrobromide (0.6 mg. Administered Orally) on Vestibular Function, as Measured by the Cold Microcaloric Method*

| | | Time of Onset of Nystagmus in Seconds | | | Duration of Nystagmus in Seconds | | | Ratio of Time of Onset and Duration of Nystagmus | |
|---|---|---|---|---|---|---|---|---|---|
| Subject | Age, Yr. | Control | Scopolamine Hydrobromide | Per Cent of Change | Control * | Scopolamine Hydrobromide | Per Cent of Change | Control | Scopolamine Hydrobromide |
| J. H..... | 15 | 33 | 26 | —21 | 146 | 190 | +30 | 1:4.4 | 1:7.3 |
| F. M..... | 60 | 35 | 35 | 0 | 155 | 144 | — 7 | 1:4.0 | 1:3.9 |
| J. H..... | 38 | 31 | 31 | 0 | 125 | 145 | +16 | 1:4.0 | 1:4.8 |
| M. M..... | 50 | 29 | 33 | +12 | 103 | 126 | +22 | 1:3.6 | 1:4.0 |
| W. M..... | 45 | 32 | 32 | 0 | 108 | 120 | +11 | 1:3.9 | 1:3.9 |

* Average of three determinations.

TABLE 5.—*Influence of Various Drugs by Oral and Parenteral Routes on Vestibular Function, as Measured by Cold Microcaloric Methods*

| | | | Time of Onset of Nystagmus in Seconds | | | Duration of Nystagmus in Seconds | | | Ratio of Time of Onset to Duration of Nystagmus | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drug | Subject | Age, Yr. | Control * | After Drug | Per Cent of Change | Control * | After Drug | Per Cent of Change | Control | After Drug |
| Diphenhydramine and 8-chlorotheophylline, 50 mg. each, orally, in separate capsules | F. G. | 48 | 33 | 33 | 0 | 111 | 111 | 0 | 1:3.4 | 1:3.4 |
| | A. B. | 49 | 27 | 28 | 0 | 109 | 106 | 0 | 1:4.0 | 1:4.0 |
| | M. B. | 37 | 33 | 33 | 0 | 111 | 90 | —19 | 1:3.4 | 1:3.2 |
| | W. M. | 45 | 31 | 37 | +19 | 102 | 97 | — 5 | 1:3.3 | 1:2.6 |
| | M. H. | 36 | 30 | 30 | 0 | 100 | 100 | 0 | 1:3.3 | 1:3.3 |
| Diphenhydramine, 50 mg., intramuscularly | M. H. | 56 | 29 | 29 | 0 | 105 | 103 | 0 | 1:3.6 | 1:3.6 |
| | W. M. | 45 | 30 | 30 | 0 | 96 | 69 | —28 | 1:3.2 | 1:2.5 |
| | F. G. | 48 | 27 | 27 | 0 | 112 | 110 | 0 | 1:4.1 | 1:4.1 |
| Diphenhydramine, 50 mg., intramuscularly; 8-chlorotheophylline, 50 mg., orally | M. B. | 37 | 29 | 40 | +38 | 106 | 70 | —34 | 1:3.7 | 1:1.8 |
| | W. M. | 45 | 32 | 32 | 0 | 97 | 85 | —12 | 1:3.0 | 1:2.4 |
| | F. G. | 48 | 29 | 35 | +21 | 100 | 91 | —10 | 1:3.5 | 1:2.6 |

* Average of three determinations.

to study their combined actions to determine the possibility of synergism. This phase of the investigation was divided into three parts: (1) the simultaneous administration orally of 8-chlorotheophylline, 50 mg., and diphenhydramine, 50 mg., in separate capsules; (2) the oral administration of 50 mg. of 8-chlorotheophylline, followed in 15 minutes by the intramuscular injection of 50 mg. of diphenhydramine (this procedure was instituted to avoid the possibility of chemical union of both drugs in the gastrointestinal tract, which would thus simulate dimenhydrinate ingestion), and (3) the intramuscular administration of 50 mg. of diphenhydramine alone studied as a control to the above.

The results are summarized in table 5. In the five subjects receiving the two drugs simultaneously in separate capsules there was no significant alteration in the time of onset and duration of the nystagmus. The ratio remained unchanged in all but one instance. The galvanic test did not reveal any effect on the vestibular mechanism in these five subjects. Diphenhydramine, when administered intramuscularly by itself, had no effect on vestibular function when studied by cold microcaloric and galvanic tests. The parenteral route did not alter the negative results obtained with the oral administration of the drug. However, when intramuscular administration of diphenhydramine was given 15 minutes after the ingestion of 8-chlorotheophylline, an increase in the time for onset of nystagmus was noted in two out of three trials associated with a decrease in the duration of the nystagmus in each of the three subjects, thus producing a decrease in the ratio in all three instances. These results were similar to those obtained with dimenhydrinate, except that they were not nearly as marked and were very transient, having completely subsided within 20 minutes. Furthermore, the galvanic stimulation was totally unaffected throughout.

## COMMENT

Of all the drugs studied, dimenhydrinate alone decidedly depressed vestibular function. It was the only drug that significantly delayed the onset of nystagmus, shortened the duration of nystagmus and increased the milliamperage necessary to effect tilting. These pharmacologic actions were dependent on the whole chemical entity, for neither of the components, diphenhydramine or 8-chlorotheophylline, produced these effects when given orally and separately. The effects noted with the cold microcaloric test when diphenhydramine was administered intramuscularly after the oral administration of 8-chlorotheophylline suggest the possibility of synergism. However, they were very transient and never attained the same degree of depression of nystagmus as noted with dimenhydrinate. Since the galvanic test failed to show any deviations from control values, it is unlikely that true synergism occurred. We cannot at this time explain these transitory actions of the combined drugs on the peripheral end organ of the labyrinth.

While it is not within the province of this paper to enter into a discussion of the various motion sicknesses, suffice it to say that until the advent of dimenhydrinate, scopolamine was generally agreed on to be the most effective medication in the prevention of sea, air and swing sickness. Yet from our data, scopolamine, if anything, increased the sensitivity of the labyrinth to incoming stimuli. However, there is well documented evidence that scopolamine is an effective drug in the prevention of motion sickness, and this observation plus the fact that nystagmus is rarely observed in the several motion sicknesses leads us to believe that a drug may be effective in motion sickness and still not depress the response to caloric stimulation. The effectiveness of many drugs advocated for motion sickness may be related to diverse pharmacologic effects, such as vestibular depression, antispasmodic action, local anesthesia and sedation. The greater effectiveness of dimenhydrinate is probably related primarily to its ability to depress vestibular function and secondarily to the possible possession of these other pharmacologic effects.

SUMMARY AND CONCLUSIONS

A technic for studying vestibular function utilizing the cold microcaloric and galvanic stimulation methods was employed to evaluate the various drugs advocated for the treatment and prevention of motion sickness.

Dimenhydrinate produced a marked and reversible depression of vestibular response which was attained by none of the other drugs investigated.

The pharmacologic actions of dimenhydrinate on vestibular function were dependent on the whole chemical entity, since neither of its components, diphenhydramine or 8-chlorotheophylline, when administered separately or in combination produced any significant diminution in labyrinthine response.

Scopolamine hydrobromide increased the sensitivity of the labyrinth to external stimulation.

# SEDIMENTATION OF AEROSOLS IN THE INTERIOR OF THE SINUSES

PAUL DAUMAS LADOUCE
ASUNCIÓN, PARAGUAY

IN COLLOIDS the diffusion of the dispersed substance, produced by the brownian movement, is retarded by the influence of gravitation, which induces sedimentation of the particles; the larger the particles, the greater is the influence of gravitation. The aerosols used in therapy of the upper respiratory passages are composed of particles of large diameter, often exceeding 1 micron; thus, their sedimentation will differ according to the plane considered, the upper or the lower horizontal plane. In the administration of aerosolized antibiotics, according to the method of Barach,[1] into certain cavities, such as the sinuses, with a poorly vascularized surface that does not easily lend itself to a good redistribution of the deposited substance, it is interesting to show this asymmetry of the sedimentation, to estimate it approximately and, in conclusion, to find a means of improving this condition. Following is a description of the experiments made toward this end.

## EXPERIMENT I

As shown in part I of the diagram, a glass tube *A* closed at its extremities, represents the nasal fossa. Tubes *D* allow chamber *A* to be filled with vapor (nebulin) or to be ventilated. Bulb *E*, of very thin rubber (prophylactic) communicating through tube *F* with the negative pressure unit (working dryly), allows the transmission to the nasal fossa of successive alternations of pressure and depression produced by the operation of its control vent. The small cavity *K*, closed at one end, represents a sinus and communicates with *A* through the glass tube, *L*, of 0.2 cm. interior diameter. Cavity *K* has its outlet into chamber *A* from its top, bottom or side, according to whether it is in an upright (position *K*), inverted (position *K'*) or horizontal position (position *K''*) respectively.

*Position K* (cavity with outlet into *A* from its top; maxillary sinuses).—As soon as the chamber is filled with vapor, the two tubes, *D*, are closed and the compressor is started. The periodic closing and opening of the control vent allows the observation of vapor penetration into cavity *K*. At the first compression, a "tongue" of vapor appears inside *K*; it disappears, moving back with the following depression. Under the conditions of the experiment, the length of this initial tongue occupies the upper third of *K*. At each following alternation of compression and depression, the same movement can be observed, but the limit reached by the peak of the nebulin is slowly displaced toward the bottom. After

From the University of Asunción.

1. Barach, A. L.; Garthwaite, B.; Soroka, M., and Anderson, F. F.: An Apparatus for the Introduction of Penicillin Aerosol into the Nasal Accessory Sinuses with a Case Report of a Patient with Chronic Sinusitis, Ann. Int. Med. **24**:97-103 (Jan.) 1946.

a few cycles, this peak takes the form of a drop and, detaching itself from the main part, always following the alternative vertical movement of the whole of the nebulin, approaches and eventually reaches the bottom of the cavity, where it spreads out.

*Position K'* (cavity with outlet into *A* from its bottom; frontal sinuses).—The tongue of the nebulin, obtained as in position *K* and animated by the alternative vertical movement, is always reproduced at the same point, at the lower third of *K'*.

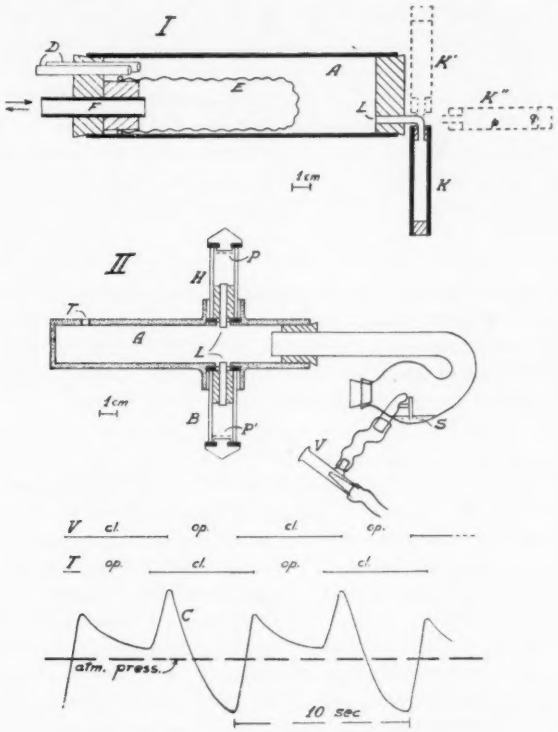


Diagram of apparatus used (see text for details).

No division of the nebulin appears, and it cannot be observed that the nebulin reaches the top of *K'*.

*Position K''* (cavity with outlet into *A* from the side; sphenoid sinuses).—The tongue of the nebulin is formed in a horizontal direction. Participating in the alternative displacements produced by the successive pressures and depressions, it soon spreads over the lower surface, *p*, and, after a few cycles, reaches the other extremity, *q*, of the cavity, like a viscous liquid trying to reach a level.

NOTE.—In order to observe the movement of the nebulin, it is convenient to use a light beam concentrated on tube *K* and directed on a black screen.

### EXPERIMENT II

As shown in part II of the diagram, the closed cavity *A*, communicating through tubes *L*, which have an interior diameter of 0.2 cm., with the upper "sinus," *H*, and the lower "sinus," *B*, is submitted to the action of pressure and decompression produced by the negative pressure unit (nasal tips relieved). Ventilation orifice *T* opens toward the exterior. The aerosol is produced by an aqueous solution, *S*, containing 6 per cent methylene blue, and its sedimentation can be detected on the white paper disks placed in *P* and *P'*.

Once the compressor is started, the vent *V*, and the orifice *T*, are periodically opened and closed (usual period, 10 seconds—closing time six seconds, opening time four seconds). A convenient phase interval between *V* and *T* allows a simultaneous closing of *V* and *T* during one second (twice during one cycle). This rhythm produces the alternations of pressure in the interior of *A* which are given in curve *C* (estimated). After operation for two minutes under these conditions, a very slight deposit of methylene blue is obtained on *P'*, which is much more intense than the deposit obtained on *P* after an action of 20 minutes (tenfold duration).

### COMMENT

The asymmetry of orifice *T* in relation to the horizontal plane has no influence on this result; the same result is obtained with *T* opening downward. The dimensions of the cavities and the orifices, the air pressure, the diameter of the particles, etc., are factors which are likely to change the particular results obtained in both experiment I and experiment II.

### CONCLUSIONS

The experiment shows (II) that the sedimentation of aerosolized particles on the upper horizontal surfaces (ceilings) of closed cavities, such as the sinuses, is about 20 times less than that obtained under the same conditions on the lower horizontal surfaces. In position *K'* (I, use of vapor), the aerosol directed toward the top does not reach the ceiling. It is suggested that experiment II be repeated, reproducing forms and dimensions of the sinuses, orifices, nasal fossa, etc., as identical as possible, with the idea of determining whether it is advisable, in order to obtain a more regular sedimentation, to treat the patient in various positions during each application, first, with the head in an upright position, and afterward with the head inclined to the right and left side respectively.

Calle Ayola 131.

# Progress in Otolaryngology

**Summaries of the Bibliographic Material Available in the Field of Otolaryngology for 1948**

## CHRONIC PROGRESSIVE DEAFNESS AND OTOSCLEROSIS

ARTHUR L. JUERS, M.D.
EUGENE L. DERLACKI, M.D.
AND
GEORGE E. SHAMBAUGH Jr., M.D.
CHICAGO

### OTOSCLEROSIS

SMITH [1] reviews the recent literature on otosclerosis. He investigated the effect of pregnancy on 73 women with otosclerosis observed at the New York Eye and Ear Infirmary. Thirty-seven, 37 per cent, of these subjects gave a history of their deafness being initiated, or, if present, increased by pregnancy. Only 21 women, 29 per cent, gave a history of familial deafness. He agrees with most other recent investigators that eugenic measures of controlling otosclerosis are not likely to be very effective. He reports one unusual case in which the hearing was temporarily improved during each of two pregnancies. He does not believe that termination of early pregnancy to prevent further progression of deafness is in general justifiable.

Fowler,[2] in his study of the blood chemistry of patients with clinical otosclerosis, found no significant changes in phosphatase values. He points out that skeletal involvement must be considerable to elevate phosphatase values, and in otosclerosis the involved area is relatively minute. The calcium and the phosphorus values were at the low limit in about two thirds of the cases.

Fowler [3] summarizes the general aspects of estrogen activity and variations, particularly the relationship to calcium and bone metabolism. Greater quantitative fluctuations of estrogen are observed in women at puberty, pregnancy and menopause. The skeletal growth differences in women and men may be related somewhat to a greater quantity of estrogen in women. It is suggested that estrogen variations may be one of the reasons for the markedly higher incidence of otosclerosis in women than in men. He feels that a patient deafened with otosclerosis may have more nervous instability than one with some other form of impedance deafness. Both emotional factors and estrogens may affect the arteriolar capillary bed.

Fowler points out that the Negro has a more stable sympathetic nervous system, fewer bone dyscrasias, less dental caries, less pyloric spasm and is less sensitive than the white race to cocaine and ephedrine. Otosclerosis is seldom observed in the Negro.

1. Smith, H. W.: Effect of Pregnancy on Otosclerosis, Arch. Otolaryng. **48**:159-170 (Aug.) 1948.

2. Fowler, E. P.: Calcium, Phosphorus and Phosphatase Activity in Otosclerosis, Arch. Otolaryng. **47**:491-498 (April) 1948.

3. Fowler, E. P.: Estrogen, Bone Metabolism and Otosclerosis, Arch. Otolaryng. **48**:637-644 (Dec.) 1948; Tr. Am. Laryng., Rhin. & Otol. Soc. **36**:72-83, 1948.

The thesis is advanced that estrogen is so closely associated with calcium and bone metabolism that it is permissible to assign to it a part in the etiology of otosclerosis, at least in people with a hereditary background.

[*Reviewers' Note.*—The otosclerotic focus is believed to increase in size in an irregular manner, with periods of quiescence alternating with periods of activity. This belief is based on histological studies showing active formation and destruction of bone in some foci, or in certain areas of some foci, while other foci or other areas consist of more mature, less vascular and less active bone. Clinically, the hearing loss in cases of otosclerosis varies considerably in its progression. Sometimes the hearing remains stationary for many years. In other cases the hearing defect increases in steplike progression, while in still others there is a more continuous rapid loss. In general, the more rapidly progressive losses occur in younger adults and are associated with a definite Schwartze sign (pinkish glow from the promontory), evidence of a highly vascular focus. The question of what factor or factors activate an otosclerotic focus is of great importance, for this matter offers the best chance of being able to arrest the disease. The fenestration operation, of course, merely by-passes the pathological process to improve hearing—it does not remove or arrest the pathological lesion.

Fowler's studies and observations on clinical otosclerosis are basic and provocative and may offer a clue to the ultimate solution of the problem.]

Altmann and Woodman [4] review the general histology and incidence of otosclerosis. They point out that conservative treatment is ineffective and that fenestration is the only alternative to wearing a hearing aid. Altmann has previously stated that infection and hemorrhages in the area of the fistula, trauma to the endosteum within the labyrinth and remaining bone chips are the most important factors that promote bony closure of the fistula. In at least 60 per cent of suitable cases they have been able to obtain a permanent restoration of practical hearing. In about 35 per cent there has been a less spectacular improvement, although sometimes still satisfactory improvement, or none at all. In about 5 per cent the hearing became worse or was entirely lost. The authors believe that a hearing aid produces a less satisfactory hearing result than a successful operation, even though the aid may provide greater amplification. Advising against pregnancy for eugenic reasons appears of doubtful value.

[*Reviewers' Note.*—The subjective impression of patients who have worn a hearing aid and whose hearing has then been restored to the practical (30 decibel) level generally is that they now hear better than formerly with their aid. Objective proof of this fact is difficult to obtain, for by pure tone and speech tests a properly selected hearing aid will elevate the threshold to well above the 30 decibel level. However, these tests are done in a quiet soundproofed room and are not comparable to the everyday experiences in more noisy environments where even the best hearing aid is at a disadvantage as compared to the natural unaided practical hearing following a successful fenestration operation.]

Passe [5] classifies his cases of clinical otosclerosis into three groups as to suitability for fenestration. Patients in group 1 are those who have good cochlear nerve

4. Altmann, F. and Woodman, DeG.: Otosclerosis, Its Pathology and Treatment, New York State J. Med. **48**:173-177 (Feb.) 1948.

5. Passe, E. R. G.: The Fenestration Operation, Irish J. M. Sc., April 1948, 145-153.

function; those in group 2 have some cochlear nerve degeneration, and those in group 3 have cochlear nerve degeneration to the extent that there is practically no chance of improving the hearing. He believes that with the present improved technic the bone conduction limit may be as low as 35 or 40 in the frequencies of 1024 and 2048. He feels that the extensive removal of periosteal bone may devascularize the labyrinth capsule sufficiently to retard the otosclerotic process. Removal of any infection in the upper respiratory tract is important.

He uses anesthesia with thiopental sodium (pentothal sodium®) after heavy premedication and thinks that the subsequent lowering of blood pressure decreases bleeding. Complete hemostasis of the soft tissues is important. The fenestra is made as long as possible, sometimes 1 cm., after wide removal of periosteal bone. He contours the lateral canal so that the fenestra will be on top of a mound. A binocular loupe microscope and irrigation are used during the creation of the fenestra. All fragments of bone dust are carefully removed from the margin of the fenestra and the flap. Complete hemostasis is again obtained. No pressure is placed on the flap overlying the fenestra. Since he has discontinued the use of the stopple and has employed the above technic there has been much less postoperative labyrinthitis. He believes that one of the main factors in subsequent closure of the fenestra is postoperative labyrinthitis, which may be increased by rough handling of the tissues and the presence of blood in the perilymph.

Tinnitus has been relieved in approximately 25 per cent of the patients operated on. Of 100 cases with stopple insertion and follow-up observation for two years, hearing was improved and lost later in 39 per cent. Hearing was not improved in 7 per cent and was worsened in 3 per cent. Following is an interim report on his last 450 cases with operation during the past 18 months, with use of his modification of Shambaugh's enchondralized fenestra:

Group I. Hearing improved to the practical level and was maintained in 86 per cent.

Group II. In only 33 per cent of this group has the hearing improved to the practical level.

Group III. In all three cases there was no improvement.

House [6] reports a comprehensive review of his first 500 fenestration cases. He creates the fenestra in a completely dry field. The burr is changed frequently to avoid excessive heat over the labyrinth. He describes his double blue line (twin bed) technic. By this method the endosteum is nearly always intact at the completion of the burring.

In the selection for fenestration, a patient is, in general, considered unsuitable if any bone conduction threshold in the speech range is below 30 decibels. Frequent calibration of the bone conduction oscillator is stressed. A negative reaction of 1024 to the Rinne test is also a prerequisite to suitability.

There were no mortalities or serious operative complications. In 1.5 per cent of the patients there developed a facial paresis seven to 10 days after operation, and all recovered completely in about a month. An annoying but not incapacitating degree of vertigo persists in about 1 per cent. Four perforations followed otitis media after operation, and four other perforations persisted after surgical

6. House, H. P.: The Fenestration Operation: A Survey of 500 Cases, Ann. Otol., Rhin. & Laryng. **57**:40-54 (March) 1948.

trauma in removal of the head of the malleus. Aural discharge, usually nocturnal, is bothersome in 20 per cent of the cases. However, since the cavities have been made smaller, and since he made the tympanomeatal flap larger by not excising the triangular posterior meatal margin, cavities have healed more rapidly and more completely.

In this series of 500 cases (including 23 nonsuitable) serviceable hearing was maintained in 66 + per cent after one year. Air conduction was worse after operation than before in 4 per cent of operations. Closure of the fenestra was assumed to have occurred in any patient who obtained improved hearing and who, subsequently, permanently lost all or any part of the original gain, providing, of course, that there was no other obvious pathological condition of the ear to account for this loss. Twelve per cent of the patients were in the closed group. Closure occurred in no instance after one year. Of those who have revisions, 25 per cent have maintained serviceable hearing longer than six months. Tinnitus was completely relieved in 24 per cent and partially relieved in 54 per cent.

Juers and Shambaugh [7] classify patients with clinical otosclerosis as follows:

Class A. These patients have good cochlear function, as evidenced by bone conduction acuity above the 30 decibel level for all speech frequencies and a negative reaction to the Rinne tests with the 256, 512 and 1024 tuning forks.

Class B. These patients show some nerve degeneration, because one bone conduction level is below 30 decibels, usually the 2048 frequency. At the 1024 frequency the reaction to the Rinne test may not be as definitely negative or possibly may be equal. At the 2048 frequency the reaction to the Schwabach test shows some shortening.

Class C. These patients show considerable evidence of nerve change, with usually two bone conduction levels below 30 decibels. The air conduction curve also shows greater loss for the high tones.

The levels of hearing as determined by speech frequency average are tabulated for two groups of cases. In group I are the last 300 consecutive cases with two year follow-up examination. In group II are the last 300 consecutive cases with one year follow-up examination. Very little change in acuity was noted in comparing one year and two year levels in group I. It was observed that patients obtaining a level of 32 or 33 usually felt that they had obtained a result equal to what a hearing aid provided before operation. This observation was particularly true for those who before operation had a hearing loss of 60 to 65 decibels. Of the *A* patients in group II, 72.4 per cent maintained a 30 decibel or better level at the one year period. Of the 226 patients in group I that obtained a 35 decibel or better level, a drop in hearing to or within 10 decibels of the preoperative level occurred owing to closure in 1.4 per cent.

[*Reviewers' Note.*—The final proof that closure of the fenestra has occurred in a particular case must await a revision. Meanwhile, one may assume that any case with a significant and useful gain and a subsequent loss of that gain is one of closure until proved otherwise. The low incidence of closure with the technic employed by the authors at the present time seems to be attributable to 6 factors:

7. Juers, A. L., and Shambaugh, G. E., Jr.: Indications For and End Results of Fenestration Surgery, Ann. Otol., Rhin. & Laryng. **57**:397-411 (June) 1948.

1. Painstaking removal of every particle of bone dust, with the help of continuous irrigation and the operating microscope

2. Enchondralization, with wide removal of the osteogenically more active periosteal layer of the capsule around the fenestra

3. Preservation of the endosteum within the labyrinth up to the outer edges of the fenestra, so that this endosteum will unite with the periosteum of the flap to produce "healing by first intention" of the bone edge

4. Covering the fenestra with the thinnest obtainable plastic skin flap, closely applied to the edges of the fenestra, as first advocated by Sourdille and modified by Lempert

5. Burnishing the bone around the fenestra with a smooth burnishing burr, as first described by Lempert

6. Minimization of fibrosis by careful hemostasis and painstaking asepsis

It is noteworthy that the delineation and appreciation of these factors were attained only through animal experimentation, permitting the incidence of closure in the operation in man to be reduced from more than 50 per cent to less than 5 per cent of fenestration operations.]

Rosen [8] made some measurements on surgical anatomy in the performance of 400 fenestration operations on cadavers. These measurements are presented in table form. Of interest is his finding that the average distance from the short process to the upper limit of Shrapnell's membrane was 1.8 mm., whereas the average distance from the short process to the fenestra was 5.7 mm. Consequently, it was impossible in his specimens to stretch Shrapnell's membrane over the fenestra.

[*Reviewers' Note.*—Most observers now agree that Shrapnell's membrane rarely, if ever, reaches and covers the fenestra. The fact that periosteum lies against the fenestra probably protects against rather than forms osteogenesis, provided that there are no particles of bone adherent to the periosteum. Periosteum is now believed to be a limiting membrane, normally tending to inhibit osteogenesis.]

Loch [9] describes his fenestration technic in which the usual technic is modified by (*a*) leaving the final layers of bone intact as a "window plate," except at the edge; (*b*) lifting this plate as one piece after all use of burrs is completed, and (*c*) removing the thin edge of the "window frame" before removal of the plate. The underlying purpose of this technic is to keep bone dust and splinters out of the perilymphatic space. He believes that removing the very thin edge of the fenestra is essential to prevent minute fractures when pressure is applied over the flap. He feels that his window plate technic is less likely to introduce bone debris into the perilymph space than is Lempert's "cupola" technic. Loch has used the technic described above for two years and states that the results have been very satisfactory.

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8. Rosen, S.: Observations on Surgical Anatomy in the Fenestration Operation, Ann. Otol., Rhin. & Laryng. **57**:1007-1017 (Dec.) 1948.

9. Loch, W. E.: A Modification of the Fenestration Operation Technic, Ann. Otol., Rhin. & Laryng. **57**:1072-1075 (Dec.) 1948.

Lempert [10] now feels that the most important factor in osteogenetic closure of a fenestra is the introduction of bone dust and splinters into the fenestral rim and perilymphatic space while the fenestra is being created with a burr. In order to overcome this problem of his former technic, he now employs a new method of opening the ampullated end of the lateral semicircular canal. The endosteal layer is exposed widely with a burr, and a bluish gray cupola of endosteal bone is created on the surgical dome of the vestibule. Bone dust is removed with irrigation. The base of the cupola is then incised circumferentially with a special knife, everted intact and removed. The bony rim of the fenestra is then burnished with lead. Results obtained by the use of this technic are not given, as, presumably, sufficient time has not elapsed.

Campbell [11] and Macfarlan discuss their hearing test findings before and after fenestration. In early cases of clinical otosclerosis there was usually less loss for the higher frequencies as compared to the low, but as fixation became complete the curve became more flat. After successful fenestration there was rarely any improvement for the 8192 frequency, and for the 4096 frequency the average improvement was much less than that for the three speech frequencies. In bone conduction tests caution must be exercised in order that masking too intensely does not interfere with hearing the test tone. The fatigue test may be helpful in differentiating nerve and conduction deafness. After operation no consistent correlation could be established between pure tone and speech levels. There was no definite relationship between the response to the fistula test and the hearing improvement obtained.

Campbell [12] reports his observations on 100 fenestrations made more than a year before. He believes that patients with less than a 35 decibel loss should not be operated on. His most suitable group includes those patients who have normal or near normal bone conduction and in whom a 25 to 30 decibel improvement will bring the hearing above the 30 decibel level. He classifies as fair those in whom a 25 to 30 decibel improvement will not bring the hearing up to a practical level and in whom bone conduction for the 1024 and 2048 frequencies has fallen below the 25 level. Such patients usually have a profound loss above the 2048 level by air. Of 72 patients with ideal operative indications, the operation was completely successful in 72.2 per cent. In 20 less suitable patients, sucess was obtained in 50 per cent. In the 23 cases with failure in the entire group, partial or complete closure was presumed to have occurred in 14. Four were revised, with success in 2. The usual minor postoperative complications are mentioned. He believes that a wrong diagnosis is an occasional cause of failure. Serious labyrinthitis is a major cause of failure. As to anesthesia, he prefers moderate premedication, procaine locally and nitrous oxide and oxygen throughout the operation.

[*Reviewers' Note.*—We are in complete accord with Campbell's statement that serous labyrinthitis is a major cause for failure. The problem of what causes this

10. Lempert, J.: Bone-Dust-Free Lempert Fenestra Nov-Ovalis, Arch. Otolaryng. **47**:280-289 (March) 1948.

11. Campbell, E., and Macfarlan, D.: Test Findings Before and After Fenestration of the Labyrinth, Arch. Otolaryng. **47**:590-607 (May) 1948.

12. Campbell, E. H.: An Analysis of Results Obtained in the Labyrinth Fenestration Operation for Otosclerosis with Report of 100 Cases, Am. Laryng., Rhin. & Otol. Soc. **36**:90-107, 1948.

condition and how to prevent it is still far from solution, but on its solution largely depends further improvements in results with the fenestration operation.]

McKenzie [13] reports on a study of 8 cases of otosclerosis in childhood out of a total of 300 otosclerotic patients seen in the deafness clinic of Middlesex Hospital. His patients have been treated by fenestration. Three of the cases with successful results are reported.

[*Reviewers' Note.*—McKenzie's rate of 8 cases is a surprisingly high incidence of otosclerosis in childhood.]

Hamberger [14] performed a fenestration in two cases of chronic adhesive otitis. In one, the hearing for speech frequencies improved from a 77 decibel level to 52 and in the other from a 72 decibel level to 45.

[*Reviewers' Note.*—The clinical differential diagnosis of adhesive deafness from otosclerosis is not always simple and clearcut, for primary otosclerotic stapes ankylosis may complicate a chronic suppurative otitis media, but in such cases the presence of otosclerosis cannot be diagnosed during life. However, provided the tympanic membrane is intact and the ear free from active or recent infection, a satisfactory hearing result may be expected by fenestration in cases of conduction deafness with good cochlear function, whether the conductive lesion is otosclerotic or adhesive.]

Farrior [15] reports his results in a series of 100 fenestrations on 85 good and 15 fair candidates. Of these, 85 obtained a practical level of 30 decibels or better, and 6 averaged a final level of 33.8 decibels. The latter patients were included in the rehabilitated group. The improvement was proportional to the degree of chochlear function determined by bone conduction studies before operation, the test with the 1024 tuning fork being the most crucial. There were five closures in the patients who have been followed from six to 24 months. Tinnitus was partially or completely relieved in 30 of the 36 patients who complained of this symptom. The points in the technic which he emphasizes are enchondralization; avoidance of trauma to the endosteal margins of the fenestra; continuous irrigation for the removal of bone dust, and protection of the flap with rayon during the last part of the operation to prevent its being seeded with bone dust.

[*Reviewers' Note.*—The latter modification is original with the author, is rational and has been adopted by the reviewers.]

Hamberger and Hyden [16] made a cytochemical study of some phases of the growth and differentiation processes during the regeneration of experimental fistulas in the skull of guinea pigs. Two hundred fistulas were made. Colchicine and sodium cacodylate were applied to some of the fistulas, because of their known antimitotic effect, in an attempt to prevent the first phase of bone regeneration—the differentiation of the osteoblasts. They found that it was not possible to prevent the regeneration in bone fistulas by means of colchicine and sodium cacodylate, but a delay of the process up to double the normal time (of the controls) was obtained.

13. McKenzie, W.: Otosclerosis in Childhood, J. Laryng. & Otol. **62**:661-670 (Nov.) 1948.

14. Hamberger, C. A.: Fenestration Operation for Chronic Adhesive Otitis, Nord. Med. **38**:1256-1259, 1948.

15. Farrior, J. B.: The Fenestration Operation for Otosclerosis: Analysis of 100 Cases, J. Florida M. A. **35**:17-23 (July) 1948.

16. Hamberger, C. A., and Hyden, H.: Cytochemical Studies on Experimental Bone Fistulae: Contribution to Research on Otosclerosis, Acta oto-laryng. **35**:479-497, 1947.

The antimitotics produced no discoverable qualitative or quantitative difference in bone regeneration, since bone repair continued being completed within double the time required for bone repair in the controls.

Juers [17] discusses the use of the Weber test after the fenestration operation to detect early postoperative depression of hearing. Hearing in about two thirds of the patients lateralizes to the ear operated on immediately after operation. This tendency continues even after the ear is healed and the patient has obtained a good hearing result. A persistent shift of hearing in the Weber test away from the ear operated on beginning three to five days postoperatively after having initially lateralized to the ear operated on seems to suggest a depression of hearing in that ear. Comparison of bone conduction audiometric studies in a group of cases before and after fenestration indicates that there is a significant decrease in threshold for the higher speech frequencies after operation. A few clinical experiments are related to support the concept that sound enters the fenestra directly. Evidence is presented to indicate that the tympanic membrane in the fenestrated ear serves to shield the round window from sound pressure. If this observation is true, then the dampening effect serves to increase the sound pressure difference between the fenestra and round window when the peak of the pressure wave reaches the fenestra. Anatomical variations, such as the relative lateral position of the fenestra in relation to the round window, may influence this pressure differential to a limited extent.

Thurlow and associates [18] used a variety of speech tests and pure tone audiometry in testing patients before and after fenestration surgery. The various tests were correlated with each other to determine their reliability on retesting. The following tests were used for determination of speech threshold:

1. Western Electric 4C audiometer recordings with two digit numbers
2. Psycho acoustic laboratory tests no. 9, with spondaic words (two syllables with equal stress)
3. Psycho acoustic laboratory test no. 12, with simple sentences
4. Psycho acoustic laboratory "PB" (phonetically balanced) word lists (monosyllabic words)

The threshold was found by determining the intensity necessary for the patient to be able to repeat half of the words or sentences correctly. The difference between this intensity and that required for normal ears to hear half of the presented speech was taken as the threshold for the patient. The percentage of phonetically balanced words repeated correctly when the sound level of the calibrating tone was 100 decibels, (i.e., 0.0002 dyne/cm.) was taken as a measure of the patient's power of auditory discrimination.

These tests were administered to 161 patients before and at intervals after the fenestration operation, and a statistical analysis of the results of these tests shows the following results.

1. Test no. 9 (spondaic words) and test no. 12 (sentences) have a standard error of measurement of about 4 decibels. The reliability is about the same as for pure tone audiometry.

17. Juers, A. L.: Observations on Bone Conduction in Fenestration Cases: Physiological Considerations, Ann. Otol., Rhin. & Laryng. **57**:28-40 (March) 1948.

18. Thurlow, W. R.; Silverman, S. R.; Davis, H., and Walsh, T. E.: A Statistical Study of Auditory Tests in Relation to the Fenestration Operation, Laryngoscope **58**:43-66 (Jan.) 1948.

2. Hearing losses for speech determined by all of the speech tests listed above correlated so closely with one another that only one of them need be used in any clinical routine.

3. The prediction of the thresholds for speech from the losses for pure tones (averaged over the speech range) is less satisfactory than the prediction from one speech test to another.

4. Discrimination for speech measured by the articulation scores obtained on word lists given at high intensity is better in cases with predominant conduction deafness than in cases with a significant amount of nerve deafness.

5. The best results from the fenestration operation, based on tests within eight months after operation, were obtained in the cases of predominant conduction deafness, but none of the tests used showed any great predictive value.

6. The average gain for speech (eight months postoperatively) was about 14 decibels. The average gain for pure tones in the speech range was about 9 decibels. Pure tone audiometry significantly underestimated the gain for speech.

7. No difference in the average immediate gain for speech seemed to be associated with any gradual general improvement in surgical technic. Reduction in the degree of exenteration of the mastoid bone also produced no detectable change in the average gain.

8. The use of a cartilage stopple to prevent bony closure of the fenestra gave, on the average, about 8 decibels less immediate gain for speech and in many cases did not prevent subsequent closure.

Silverman and associates [19] present a study in which the social adequacy of patients with fenestration is compared with the patient's subjective evaluation of improvement in answer to a questionnaire. The social adequacy index is defined as the average articulation score obtained when phonetically balanced word lists are played at sound pressure levels of 20, 35, and 50 decibels above the normal "PB" threshold. These three levels of intensity represent the intensity levels of weak speech, average speech, and loud speech, respectively. It was observed that social difficulty began when the index fell below 67. Patients with an index higher than this were considered to have full social adequacy. An index of 33 was found to be the threshold of social adequacy." If the operation brought the index from below this threshold index to above it, definite practical value from the operation was experienced by the patient, and the operation was considered as a practical success. The poor correlation between patients' self-rating and detailed speech testing indicated that the questionnaire method is not dependable as a means of accurately assessing fenestration results.

### MÉNIÈRE'S SYNDROME

Eagle [20] points out that those patients who have tinnitus and impaired hearing before the attack of vertigo and in whom the tinnitus and deafness promptly subsides at the onset of vertigo should be given a diagnosis of Lermoyez' syndrome rather

19. Silverman, S. R.; Thurlow, W. R.; Walsh, T. E., and Davis, H.: Improvement in the Social Adequacy of Hearing Following the Fenestration Operation, Laryngoscope **58**:607-631 (July) 1948.

20. Eagle, W. W.: Lermoyez's Syndrome: An Allergic Disease, Ann. Otol., Rhin. & Laryng. **57**:453-464 (June) 1948.

than Ménière's. He states that in the true Ménière syndrome the tinnitus and deafness follows rather than precedes the onset of vertigo. Lermoyez' syndrome is seen in a somewhat younger age group, and in his experience has been due to allergy, urticaria being a commonly associated condition. The prognosis as to cochlear symptoms is much better in Lermoyez' syndrome that in Ménière's.

Schall and Rambo [21] carried out experimental studies on monkeys to determine the histological changes which take place in the labyrinth after the membranous structures are destroyed by the technic of electrocoagulation advocated by Day. After the initial serous exudation, healing of the labyrinth occurred by fibrosis with progressive changes to bone formation. The damage to the membranous labyrinth of the vestibule and semicircular canals was complete and would be expected to eliminate the vertigo of Ménière's syndrome. The cochlea appeared normal in one ear, and in another there was only localized damage to the organ of Corti adjacent to the vestibule. The other ears showed definite damage to the functional elements of the cochlea. However, even in the presence of a normal cochlea, the changes in the vestibule would, in all probability, interfere considerably with any useful hearing by air conduction.

An endaural transtympanic approach for surgical destruction of the membranous labyrinth in cases of Ménière's disease is described by Lempert.[22] Through a modified endaural incision, the posterior portion of the tympanic membrane is freed from its sulcus. The long process of the incus is cut off and removed along with the entire stapes. The round window membrane is destroyed with a burr opening the cochlear scalae widely. The openings are not closed. The dislodged portion of the drum membrane is then replaced in position. This procedure relieves the tinnitus as well as the vertigo. Lempert believes that surgical destruction of only the vestibular portion of the membranous labyrinth does not necessarily result in complete degeneration of the organ of Corti.

Bronson [23] reports on 50 consecutive cases of division of the acoustic nerve, with follow-up observation thereafter from one to eight years. He believes that the caloric response is of little value in the diagnosis, inasmuch as some persons showed an increase, some a decrease and others no difference between the two ears. His indications for operation coincide with those suggested by others in the present review. His chief objection to operations on the inner ear is that both cochlear and vestibular function are destroyed. In his group of nerve sections, one patient aged 62 died five days after operation because of a cerebral hemorrhage. One patient with complete facial paralysis recovered after seven months. Twenty of the operations were partial divisions and 30 were total. All but two patients were completely relieved from vertigo. These two patients had partial divisions, and caloric tests revealed some vestibular response. In one patient a subsequent total division gave complete relief. For this reason the author now feels that total division of the nerve is preferable unless there is some special reason for preserving the residual hearing. Greater relief from tinnitus was obtained in the total than in the partial sections.

21. Schall, L. A., and Rambo, J. H. T.: Electrocoagulation of the Membranous Labyrinth: Experimental Histological Studies in the Monkey, Ann. Otol., Rhin., & Laryng. **57**:590-602 (Sept.) 1948.

22. Lempert, J.: Lempert Decompression Operation for Hydrops of the Endolymphatic Labyrinth in Ménière's Disease, Arch. Otolaryng. **47**:551-570 (May) 1948.

23. Bronson, S. R.: Ménière's Disease: Its Surgical Treatment by Division of the Acoustic Nerve, Am. J. Surg. **75**:159-170 (Jan.) 1948.

In the total divisions, tinnitus was abolished in 30 per cent, improved in 40 per cent and unimproved in 30 per cent. In partial division, tinnitus was abolished in 15 per cent, improved in 25 per cent and unimproved in 60 per cent. This rate of improvement is another reason for favoring total division.

[*Reviewers' Note.*—The definitely greater mortality and morbidity associated with intracranial section of the eighth nerve, as contrasted with surgical destruction of the labyrinth by the Cawthorne or Day technic, makes the latter the procedure of choice in intractable unilateral Ménière's disease that resists conservative medical management. Fortunately, only a small percentage of patients ever require destructive surgery.]

Farrior [24] states that regardless of the type of conservative treatment used, benefit is obtained in 70 to 85 per cent of cases. If surgery is indicated he prefers destruction of the labyrinth in cases of unilateral Ménière's disease in an unserviceable nerve-deaf ear. He reports eight cases in this category. In one patient hydrops subsequently developed in the remaining ear. The more formidable neurosurgical differential section of the vestibular nerve is reserved for bilateral Ménière's disease.

Ireland [25] states that the caloric test (either Kobrac or Atkinson technic) showing one labyrinth with a deviation from a normal response is of great value in localization of the lesion, particularly in cases in which surgical procedure is proposed. About 10 per cent of all patients treated require surgical intervention because of disabling vertigo which does not respond to medical measures. His surgical observations are based on 90 patients who had resection of the eighth nerve and 33 with surgical destruction of the labyrinth (31 of the latter were from Dr. J. A. Sullivan's service). He reports one death for each method of operation. The good results obtained by either surgical procedure seemed to be comparable.

Fowler [26] reports on three patients with Ménière's disease and one case of pseudo Ménière's disease treated with streptomycin, which, through its toxic effects on the vestibular mechanism, produces in certain dosage a virtual bilateral nerve section. The dosage was 4 Gm. daily in 0.5 Gm. doses every three hours. All four patients seen from six to 10 months after therapy were relieved of their violent vertigo, although by three momentary dizziness was experienced on quick turns. All patients seemed to have shown adequate compensation. Patients over 50 years of age do not compensate well and should not be selected for treatment with streptomycin. The hearing was not changed. Regular medical treatment should be tried first. When severe deafness is present on one side and the other side is normal, the cauterization operation of Day or the ablation operation of Cawthorne is the treatment of choice.

Passe and Seymour [27] report 12 cases of Ménière's syndrome treated by surgical removal of the stellate ganglion and division of the preganglionic fibers of the first

24. Farrior, J. B.: Ménière's Disease: Its Treatment, New Orleans M. & S. J. **101**:168-169 (Oct.) 1948.

25. Ireland, P. E.: The Diagnosis and Treatment of Ménière's Symptom Complex, Canad. M. A. J. **58**:269-273 (March) 1948.

26. Fowler, E. P., Jr.: Streptomycin Treatment of Vertigo, Tr. Am. Acad. Ophth. **52**:293-301 (March) 1948.

27. Passe, E. R. G., and Seymour, J. S.: Ménière's Syndrome: Successful Treatment by Surgery on the Sympathetic, Brit. M. J. **2**:812-816 (Nov.) 1948.

and second thoracic nerves. In two cases the vertebral artery was stripped, and in four either ligated or divided after the adventitious coat had been removed. The anterior approach was used. The authors feel that the predominant etiological factor of Ménière's syndrome is vasoconstriction. The vertigo was completely relieved in all but one case. Tinnitus was completely relieved in three cases and partially in six; in the remaining three there was no change. In the majority of the cases there was a hearing improvement and a decrease in the feeling of fulness.

### BLAST INJURY

Perlman [28] studied the traumatizing effect of shock pulse on the cochlea of rabbits. The disturbance produced by an explosion is called a shock pulse, and in these experiments it was produced by a starting pistol. The middle ear was exposed via the bulla, and the threshold of the tensor tympani muscle reflex was determined by introducing calibrated sound into the external auditory canal. The shock pulse was then applied through the bulla. After various intervals of time the threshold of the tympanic muscle reflex was again determined in order to assess the degree of damage to cochlear function. Microscopic studies of the inner ear were then made. The more widespread and severe histological damage was usually associated with the severest functional loss, but complete obliteration of the reflex response was sometimes noted when only a limited histological lesion was seen. This lesion was seen chiefly in the acute experiment. Possibly, there was tissue damage not visible to microscopic study. The greatest visible trauma was usually in the upper end of the basal coil (near the middle of the cochlear duct). The conduction apparatus usually showed no evidence of trauma. Two acute functional reactions were observed: one was the evidence of recovery of function from within a few minutes to several hours after exposure; the other was a rather rapid progressive obliteration of function within a few minutes after the immediate postblast threshold was taken. Partial recovery of function was seen in some of the chronic experiments and in one animal, even after complete obliteration of the reflex response.

Baron [29] reviews his experience with blast injuries in World War II. The perforation was located in the posterior and central portions of the tympanic membrane as often as in the anterior. Perforations with infections closed spontaneously as often as those not infected. Frequent cleansing of the canal and the middle ear (once or twice daily) by topical suction was probably the most effective aid in healing the otitis media. The size of the perforation was no factor in the eventual outcome of healing provided a complete margin of tympanic membrane persisted. The use of a thin membrane over the perforation increased the incidence of healed perforations.

[*Reviewers' Note.*—The immediate application of a small patch of sterile paper to the tympanic membrane accidentally torn during the fenestration operation greatly increases the speed and incidence of spontaneous closure. This patch probably acts as a splint to which the torn edges tend to adhere, thereby preventing their curling in or remaining widely separated.]

28. Perlman, H. B.: Minimal Shock Pulse Trauma to the Cochlea, Acute and Chronic, Laryngoscope **58**:466-502 (June) 1948.

29. Baron, S. H.: The Repair of the Ear Drum in Blast Injuries, Ann. Otol., Rhin. & Laryng. **57**:143-152 (March) 1948.

MISCELLANEOUS

Loch and Tucker [30] studied the hearing changes in patients with syphilitic deafness treated with penicillin. The hearing promptly became better in all of five patients with acute syphilitic meningitis, and the improvement was sustained. Of seven patients with deafness associated with late neurosyphilis, four had no change in hearing and three had delayed but significant improvement in hearing acuity. Other methods of treatment in the past have rarely improved the hearing in patients with deafness due to late neurosyphilis. The hearing improvement started in the low tones and then became more general.

Hardy [31] discusses the methods available at present for detecting the presence of a psychic element in the impairment of hearing manifested by some persons. A psychogenic component is to be suspected whenever the speech reception threshold is significantly better (lower) than that for pure tones. A positive reaction to the Doerfler-Stewart test is another consistent finding. He reports several cases in which an obvious improvement in hearing was found during a retest done while the patient was in a state of "minimal hypnosis." He feels that this deep suggestion method of investigating these patients should be a routine step in all instances in which a psychogenic factor is suspected.

Lebo and Palermo [32] modified the Pohlman prosthesis so that it may be used effectively in a radical mastoid cavity in which no bony meatus exists. The acrylic support in the concha must be individually fitted, but the rest of the prosthesis does not.

The effects of multiple sclerosis on the auditory nerve were studied by Von Leden and Horton.[33] Varied changes in hearing acuity beyond normal variations were found in 43 per cent of patients with multiple sclerosis as compared to 18 per cent of a comparable group of normal healthy persons picked at random. Other authors have found histological involvement of the cochlear and vestibular nuclei by multiple sclerosis. True rotatory vertigo was present in 18 per cent. Neurological nystagmus was present in 43 per cent.

Johnson and Zonderman [34] report their findings concerning hearing acuity, tinnitus and vertigo in 76 patients with severe essential hypertension admitted to a hospital for splanchnicectomy. Defective hearing was present in only 10 per cent. Half of these had a conductive lesion. However, a significant dip in the audiometric curve at the 2896 and 4096 frequencies was noted in 42 per cent. Dizziness was complained of by 46 per cent. This sensation was often only a sense of giddiness and slight imbalance rather than a true loss of equilibrium with nystagmus. Tinnitus was present in 30 per cent. It was usually of a ringing quality, intermittent and infrequently incapacitating. A few patients who had severe constant tinnitus of a throbbing nature usually were relieved after splanchnicectomy.

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30. Loch, W. E., and Tucker, H.: Penicillin Treatment of Nerve Deafness Due to Syphilis, Ann. Otol., Rhin. & Laryng. **57**:167-180 (March) 1948.

31. Hardy, W. G.: Special Technics for the Diagnosis and Treatment of Psychogenic Deafness, Ann. Otol., Rhin. & Laryng. **57**:65-95 (March) 1948.

32. Lebo, C., and Palermo, A.: Tantalum-Acrylic Middle Ear Prosthesis, Ann. Otol., Rhin. & Laryng. **57**:1026-1031 (Dec.) 1948.

33. Von Leden, H., and Horton, B. T.: Auditory Nerve in Multiple Sclerosis, Arch. Otolaryng. **48**:51-57 (July) 1948.

34. Johnson, L. F., and Zonderman, B.: The Hearing Acuity, Tinnitus and Vertigo in Essential Hypertension, Laryngoscope **58**:374-379 (May) 1948.

[*Reviewers' Note.*—The dizziness of hypertension is nearly always of cerebral vascular origin and should not be confused with true labyrinthine rotary vertigo. The tinnitus of hypertension may also be of central origin, except when it is a throbbing synchronous with the pulse, in which case it is probably due to increased pulsations of the carotid artery.]

Lumio [35] studied the hearing in 700 patients who were exposed to the influence of gases, especially carbon monoxide, in their work. Hearing deficiencies were noted in 78.3 per cent of the patients suffering from chronic carbon monoxide poisoning as compared to 26.7 per cent in those who had no definite objective signs of poisoning. A typical curve showed a steep drop, beginning between the 1000 and 2000 frequency level. The loss was usually symmetrical.

Lundgren [36] made a hearing survey of 1,426 children in the elementary schools of Lund. Audiometric testing disclosed hearing impairment for the high tones in 9.8 per cent and for all tones in 5.8 per cent. None of the former and only 3.8 per cent of the latter impairment was discovered with the whispering test. In 0.35 per cent there was a loss great enough to constitute a serious handicap, and 20.5 per cent had suffered from acute otitis media. In 72 per cent of these there was good hearing. Adenoidectomy had been performed on 31.3 per cent of all the children. Recurrence of adenoid tissue after adenoidectomy was observed in 4 per cent.

Swartz [37] presents a case report of sensitivity to diphenhydramine (benadryl®). A patient with ragweed pollen sensitivity was given diphenhydramine and obtained good relief. However, on the sixth day, the patient awoke with vertigo, nausea, vomiting and bilateral humming tinnitus. Medication was discontinued, with a subsiding of labyrinthine symptoms. Four weeks later after the hay fever season was over, another attack of vertigo and tinnitus was precipitated by a 25 mg. dose of diphenhydramine.

Winckel [38] reviews the total of 17 cases reported in the medical literature which advanced the theory that quinine was a cause of congenital deafness or blindness in children whose mothers had taken quinine during pregnancy. He expresses some doubt concerning the deleterious effect of quinine for the following reasons:

1. The cases reported are rare.

2. The congenital defects appear to be no more serious whether large or small quantities of quinine were given.

3. Deaf-mutism, according to the census of 1930, is no more frequent in endemic malarial states where much quinine is used.

Furthermore, the 17 cases mentioned were reported before there was any knowledge concerning deafness following prenatal German measles.

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35. Lumio, J. S.: Hearing Deficiencies Caused by Carbon Monoxide (Generator Gas), Acta oto-laryng., 1948, supp. 71, pp. 1-112.

36. Lundgren, N.: Impairment of Hearing in School Children and Its Causes, Nord. Med. **38**:1015-1021, 1948.

37. Swartz, H.: Untoward Side-Effect Following Benadryl Administration, New York State J. Med. **48**:88-89 (Jan. 1) 1948.

38. Winckel, C. W. F.: Quinine and Congenital Injuries of Ear and Eye of the Foetus, J. Trop. Med. **51**:2-7 (Jan.) 1948.

# Special Reports

## HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE AND REHABILITATION OF THE AMERICAN MEDICAL ASSOCIATION

**As of Feb. 1, 1951**

Aurex Model F

Aurex Model H
Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Beltone Mono-Pac

Beltone Harmony Mono-Pac

Beltone Symphonette

Beltone Mono-Pac Model M
Mfr., Beltone Hearing Aid Company
1450 W. 19th St.
Chicago 8

Cleartone Model 500

Cleartone Regency Model
Mfr., American Sound Products, Inc.
2454 S. Michigan Ave.
Chicago 16

Dysonic Model 1
Mfr., Dynamic Hearing Aids, Inc.
1042 Atlantic Ave.
Brooklyn 16

Electroear Model C
Mfr., American Earphone Co., Inc.
10 E. 43rd St.
New York 17

Gem Model V-35

Gem Model V-60
Mfr., The Gem Ear Phone Co., Inc.
50 W. 29th St.
New York 1

Maico Atomeer

Maico UE Atomeer

Maico Quiet Ear Models G and H
Mfr., The Maico Company, Inc.
21 N. Third St.
Minneapolis 1

Mears Aurophone Model 200

1947-Mears Aurophone Model 98
Mfr., Mears Radio Hearing Device Corp.
1 W. 34th St.
New York 1

Micronic Model 101 (Magnetic Receiver)

Micronic Model 303
Mfr., Micronic Company
727 Atlantic Ave.
Boston 11
(See Silver Micronic)

Microtone T-3 Audiomatic

Microtone T-4 Audiomatic

Microtone T-5 Audiomatic

Microtone Classic Model T9

Microtone Model 45
Mfr., The Microtone Company
Ford Parkway on the Mississippi
St. Paul 1

National Cub Model (C)

National Standard Model (T)

National Star Model (S)

National Ultrathin Model 504

National Vanity Model 506
Mfr., National Hearing Aid Laboratories
815 S. Hill St.
Los Angeles 14

Otarion Model E-1

Otarion Model E-1S

Otarion Model E-2

Otarion Model E-4

Otarion Models F-1 and F-2
Mfr., Otarion, Inc.
159 N. Dearborn St.
Chicago 1

Paravox Models VH and VL
(Standard)

Paravox Model XT ('Xtra-Thin)

Paravox Model XTS ('Xtra-Thin)

Paravox Model Y (YM, YC and YC-7)
(Veri-Small)
Mfr., Paravox, Inc.
2056 E. 4th St.
Cleveland 15

Radioear Permo-Magnetic Multipower

Radioear Permo-Magnetic Uniphone

Radioear All-Magnetic Model 55

Radioear Model 62 Starlet
Mfr., E. A. Myers & Sons
306-308 Beverly Road
Mt. Lebanon
Pittsburgh 16

Silver Micronic (Magnetic and Crystal)
Models 202M and 202C
Mfr., Micronic Company
727 Atlantic Ave.
Boston 11
(See Micronic)

Silvertone Model 103BM
Mfr., National Hearing Aid Laboratories
815 S. Hill St.
Los Angeles 14

Distr., Sears, Roebuck & Company
925 S. Homan Ave.
Chicago 7

Silvertone Model M-35
Mfr., Micronic Company
727 Atlantic Ave.
Boston 11

Distr., Sears, Roebuck & Company
925 S. Homan Ave.
Chicago 7

Silvertone Model P-15
Mfr., W. E. Johnston Mfg. Company
708 W. 40th St.
Minneapolis 8

Distr., Sears, Roebuck & Company
925 S. Homan Ave.
Chicago 7

Solo-Pak Model 99
Mfr., Solo-Pak Electronics Corp.
Linden St.
Reading, Mass.

Sonotone Model 600

Sonotone Model 700

Sonotone Model 900

Sonotone Models 910 and 920

Sonotone Model 925
Mfr., Sonotone Corporation
Elmsford, N. Y.

Super-Fonic Hearing Aid
Mfr., American Sound Products, Inc.
2454 S. Michigan Ave.
Chicago 16

Televox Model E
Mfr., Televox Mfg. Company
1307 Sansom St.
Philadelphia 7

Telex Model 22

Telex Model 97

Telex Model 99

Telex Model 200

Telex Model 1700
Mfr., Telex, Inc.
Telex Park
Minneapolis 1

Tonemaster Model Royal
Mfr., Tonemaster, Inc.
400 S. Washington St.
Peoria 2, Ill.

Trimm Vacuum Tube Model 300
Mfr., Trimm Distributors, Inc.
400 Lake St.
(P. O. Box 489)
Libertyville, Ill.

Unex Model A

Unex Midget Model 95

Unex Midget Model 110
Mfr., Nichols & Clark
Hathorne, Mass.

Vacolite Model J
Mfr., Vacolite Company
3003 N. Henderson St.
Dallas 6, Texas

Western Electric Model 63

Western Electric Model 64

Western Electric Models 65 and 66
Mfr., Western Electric Co., Inc.
120 Broadway
New York 5

Zenith Model 75

Zenith Miniature 75
Mfr., Zenith Radio Corporation
6001 W. Dickens Ave.
Chicago 39

(All the accepted hearing devices have vacuum tubes.)

Accepted hearing aids more than five years old have been omitted from this list for brevity.

TABLE HEARING AIDS

Aurex (Semi-Portable)
Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Precision Table Hearing Aid
Mfr., Precision Hearing Aids
5157 W. Grand Ave.
Chicago 39

Sonotone Professional Table Set Model 50
Mfr., Sonotone Corporation
Elmsford, N. Y.

# Abstracts from Current Literature

## Ear

THE MANAGEMENT OF EAR PROBLEMS IN CHILDREN. MARVIN F. JONES, New York State J. Med. **49**:2825 (Dec. 1) 1949.

Jones urges that the partially deafened child be examined for nasopharyngeal growths regardless of a previous adenoidectomy, for, while thorough removal of tonsils usually eliminates recurrence, this is not always true of adenoids, which have a tendency to recur, no matter how thoroughly they were excised. He insists on the use of the nasopharyngoscope but realizes that many children will defeat this purposeful examination. The author notes that there are fewer cases of acute and chronic suppurating ears in children now than formerly, and he ascribes this, not to the current use of antibiotics exclusively, but to good surgery, the clearing up of sinusitis and better attention to malnutrition and allergic manifestations. Concerning the use of radium, the author is not overly enthusiastic, although he recognizes the value of positive results reported from dependable sources. Sinusitis is frequently associated with infected tonsils and adenoids. It can often be successfully treated without surgery of the sinuses. Seven "run of the mill" case reports are included in which successful management restored a child's hearing. It is important not to place a child aside in a "deaf class" but to encourage association with normal children, save, perhaps, in the case of congenitally deafened children. With such a child much can be accomplished by individual instruction, patience and fortitude. Often they can become self supporting and not introverted because of their misfortune. Jones concludes that the otologist will not get the best results unless he does the work himself.

I. W. VOORHEES, New York.

THE INSULATING EFFECT OF THE MASTOID PROCESS ON BONE CONDUCTION. E. MARKEY PULLEN, New York State J. Med. **50**:301 (Feb. 1) 1950.

Pullen stresses the psychology of deafness and compares blindness with bad hearing. Compassion is bestowed on the latter condition, while deafness is a subject for joke and ridicule. The effect on the deafened is withdrawal from society, a sense of insecurity, depression and frustration. As a result of the fenestration operation, which necessitates a choice of patients on the basis of examination as to integrity of the auditory nerve, "it is possible that our interpretation of bone conduction loss is inaccurate and that other factors besides nerve lesions may be the cause of lowered bone conduction." Four categories are set up, based on stereoscopic roentgenograms and audiometer readings. These provide data helpful in making the classification:

1. Large cellular mastoid. This usually signifies extensive loss of bone conduction, depending somewhat on the age of the patient.

2. Small cellular mastoid. This is revealed mostly in women by stereoscopic roentgenograms. The bone conduction is normal or only slightly impaired.

3. Underdeveloped mastoid. This occurs in the forward sinus with cancellous bone at tip, and solid or thickened bone in the inner ear. The bone conduction is normal or only slightly impaired.

4. Sclerotic mastoid. This is commonly found as a residual of chronic purulent otitis media. The bone conduction is normal or only slightly impaired.

Pullen concludes that lowered bone conduction may not indicate auditory nerve lesions. However, the large cellular mastoid is an effective sound insulator and may be deceiving. It may be responsible for bone conduction loss to 25 decibels.

I. W. VOORHEES, New York.

## Nose

EXPERIMENTAL STUDIES ON HEADACHE: PAIN ORIGINATING IN NASAL AND PARANASAL STRUCTURES. GERVAIS WARD MCAULIFFE, GEORGE CHRISTOPHER MUELLER and HAROLD G. WOLFF, New York State J. Med. **50**:1113 (May 1) 1950.

In 1943 studies leading to the writing of this paper were begun in the New York Hospital, Department of Surgery. The authors refer to the vast amount of radical surgery performed more than 10 years ago as compared with now. Since the advent of antibiotics not only otorhinolaryngology but the entire practice of medicine has changed.

Diseases of the upper nasal areas cause pain in the upper part of the face and head and in the vertex. Middle and lower lesions give rise to pain in the temples, zygomas, jaws and teeth. Four main structures were observed as sources of pain: (1) the inferior turbinates, (2) the ostiums, (3) the nasal septum and (4) the paranasal sinuses. The turbinates may be involved in infectious rhinitis, acute hypertrophic rhinitis, hypertrophic rhinitis, allergic rhinitis and polypoid degeneration. In managing these, the mildest medication with the least trauma should be the rule. If one can obtain proper aeration by constriction of the turbinal mucous membrane and opening of the ostiums, drainage will relieve the irritation. General management should include rest in bed in a warm, airy, humidified room, use of antipyretics, increased intake of fluids, enemas rather than catharsis, heat (preferably with an infrared lamp) and chemotherapy against bacterial invasion.

For hypertrophic rhinitis, the authors recommend local anesthesia and chemical cauterization of the inferior turbinates (with use of a chromic acid bead, for example). Vasoconstrictors for permanent relief are not recommended.

To relieve allergic rhinitis, one must try to identify the irritant. The turbinates are pale and boggy with much watery exudate. The eosinophils are increased. Antihistamines may bring relief.

Polypoid degeneration may be dealt with surgically, but as much tissue as possible should be conserved.

Ostiums of all sinuses except the sphenoid are found under the middle turbinate. Here constrictors must be applied topically, and direct suction to the region will aid in evacuation of excessive secretion. Total suction to one side of the nose may cause chronic passive congestion with rather constant nasal obstruction. Infraction of a turbinate toward the midline may be useful, but removal is not recommended. Irrigations with warm and saline solution and treatment with infrared rays bring relief.

Septal deviations are associated with hypertrophy of the inferior turbinate on the concave side of the partition. If of severe degree, as in high deviations with contact points, surgical intervention is indicated.

Chronic infections of the nasal sinuses probably produce little pain unless pus is under pressure through closure of the ostiums.

Some 80 patients were studied with a view to analyzing the incidence and origin of pain. When the diagnosis was established, relief of pain was usually easily accomplished.

I. W. VOORHEES, New York.

## Miscellaneous

EXPLOITATION OF THE ANTIHISTAMINIC DRUGS. EDITORIAL, New York State J. Med. **50**:665 (March 15) 1950.

The writer of this editorial discusses the exploitation of the cold remedies through radio and newspaper advertising. The advertisers boldly state that these preparations are free from all harm, are certain to prevent or promptly cure colds and may be bought "at your own drug store." The writer quotes from the *New England Journal of Medicine*, whose editors castigate the *Readers Digest* for the article in the December 1947 issue extolling the virtues

of the antihistamines. *The Journal of the American Medical Association* (Dec. 10, 1949), through the Council on Pharmacy and Chemistry, warns against indiscriminate use of these drugs by persons who are "sold" through sensational advertising. The Council stresses the soporific effect, which may manifest itself while one is at work or driving a car or locomotive. In all fairness to the manufacturers, the labels on some of the packages call attention to this danger. Airplane pilots have long known about this effect. The Child Welfare Committee of the Medical Society of the County of New York states that the new antihistamine drugs may be more highly toxic to children than to adults. Tablets may be left about the rooms within easy reach of children, who may mistake them for candy. There is hope, says the editorial writer, that manufacturers of drugs will clean up their own Augean stables before legislation is required to compel them to do so, but this expectation is also regarded as doubtful of fulfilment.

I. W. VOORHEES, New York.

MODIFIED NASAL DIPHTHERIA IN IMMUNIZED PERSONS. WARREN WINKELSTEIN JR., New York State J. Med. **50**:1117 (May 1) 1950.

The author reemphasizes that "missed cases" are highly important in setting up a community infection and that nasal diphtheria may be overlooked more frequently than is generally believed. Moreover, one should not assume that previous efforts at immunization insure against any infectious disease. The factors involved are so variable that the desired immunity may not have been obtained at all or perhaps only partially.

Four cases are reported. All the patients had varying degrees of mucopurulent nasal discharge, with ulcerations at the mucocutaneous junction in the nares. Fever was not notable. Nasal cultures in three cases confirmed the diagnosis of diphtheria, but throat cultures were negative in all cases. Membranes were not seen; there was little blood-stained discharge, and no complications were found in the heart or elsewhere after the acute condition had cleared. There were no paralyses. Antitoxin should always be administered as a preventive of complications and as an aid to early relief and cure. The possibility of contagion must be emphasized, for diphtheria in any form is easily acquired. Winkelstein rightly stresses the need among medical practitioners for a high degree of "suspicion" of this disease and the taking of cultures in every case of "running nose," especially in children.

I. W. VOORHEES, New York.

RECURRENT MENINGITIS AND CEREBROSPINAL RHINORRHEA. MORRIS KLEINFELD, MORRIS AXELROD and AARON COHEN, New York State J. Med. **50**:1244 (May 15) 1950.

Recurrence of meningitis, regardless of the serological type, is extremely low, and, according to this article, no case has been recorded of a true recurrent attack of pneumococcic meningitis with recovery. The authors report the case of a 34 year old woman, who was first seen at Coney Island Hospital Nov. 17, 1944, with headache, vomiting and stupor. She had had chronic otitis media for 15 years with residual deafness. "A nasal growth was removed and discharge ceased." A sample of spinal fluid showed type 15 Pneumococcus. The Wassermann reaction was negative. Sulfadiazine and penicillin were given simultaneously, and there was some improvement but the headache persisted. By November 26 the patient was without symptoms, and she was discharged on December 16. On her second admission, Sept. 7, 1947, she complained of headache and stiffness of the neck of one day's duration, preceded by "a cold, fever, headache and a persistent rhinorrhea." The spinal fluid showed a type 23 Pneumococcus. Again, sulfadiazine and penicillin were administered concomitantly, with improvement until the patient was dismissed on Sept. 22, 1948. Roentgenograms showed the skull to be normal except for a polyp in the right antrum. The follow-up in the outpatient department was not successful. On the third admission, July 27, 1949, she again had headache, fever and stiffness of the neck. The spinal fluid was cloudy, but culture and smear preparations revealed no infection. The nasal fluid gave a positive reaction for sugar and negative reaction for mucin. Indigo carmine injected into the spinal canal appeared in the nasal secretion in 30 minutes. The same treatment was given as on the previous occasions with gradual improvement. The patient was transferred to a neurological hospital for possible surgery of the cribriform plate. However this was not undertaken, or is not reported in this record.

"Cerebrospinal rhinorrhea may be traumatic or spontaneous." Head injuries or surgical operations affecting the cribriform plate may be causes. The plate condition may be congenital. There was no known cause determinable in this case, which "falls into the group of spontaneous cerebrospinal rhinorrhea due to congenital defect of the cribriform plate." This anomaly occurs more frequently in women. Ten of 12 patients were women in the 30 to 50 year age group. Diagnosis is achieved by laboratory tests, specifically by the finding of sugar in the spinal fluid or by recovery in the nasal fluid of indigo carmine previously instilled into the spinal canal. Surgical intervention consists of craniotomy with insertion of a muscle flap over the dehiscent cribriform plate. The procedure "has proved highly successful."

IRRADIATION OF ADENOID TISSUE. J. M. LEMEE and L. PORTE, Acta oto-rhino-laryng. belg. **3**:378, 1949.

Radium treatment of enlarged adenoid tissue in the nasopharynx should not be considered as a panacea. One should look for and deal with the many causes of lymphoid hyperplasia, in addition to irradiating the tumor itself. These causes are the following: (1) chronic sinusitis, (2) nasal allergy, (3) status thymicolymphaticus and (4) hereditary syphilis and tuberculosis.

In particular, any suppuration originating in the nasal sinuses should be cleared by the displacement method and a roentgenogram of the nasal sinuses made before irradiation of the nasopharynx is performed. The authors use Crowe's method of three treatments separated by two week intervals, a 50 mg. radium applicator made of Monel metal being applied for 12 minutes. For children, smaller doses should be used; the writers apply the radium one minute for each year of age up to 10; a treatment is given every two weeks. This is because a child's nasopharynx is smaller than an adult's and more sensitive to radiation; moreover, the pituitary gland is much closer to the pharyngeal wall than it is in an adult. HERSON, Chicago.

# Society Transactions

## AMERICAN LARYNGOLOGICAL ASSOCIATION

**Ralph A. Fenton, M.D., *President, Presiding***

**Louis H. Clerf, M.D., *Secretary***

***Seventy-First Annual Meeting, San Francisco, May 23-24, 1950***

**Abstracted by Samuel Salinger, M.D.**

**Azygos Lobe of the Lung.** Dr. J. Hardie Neil, Aukland, New Zealand.

Dr. Neil's report concerned a rare case of an anomaly of the upper lobe of the right lung in which an accessory lobe was present, owing to cleavage of the upper segment. Four subsegmental orifices were found. The condition is presumed to be due to passage of an anomalous azygos vein between the two main branches of the upper segmental bronchus. The so-called azygos lobe is found in less than 1 per cent of autopsies.

**Nervus Terminalis.** Dr. Olaf Larsell, Portland, Ore.

Dr. Larsell described the nervus terminalis as an autonomic nerve serving the blood vessels and Bowman's glands. It accompanies the olfactory bulb along the cribriform plate, following its branches along the septum and lateral wall of the nose. Sections show multipolar cells spreading over the vessels with axons following down to the very small arterioles. Also, branches were traced directly to Bowman's glands. The function of these fibers is assumed to be sensory and corollary to the olfactory nerve, the fibers being stimulated by the secretion of the glands. A motor component of the nerve is, at present, under study. The roots of the nervus terminalis end in the septal nuclei, the olfactory lobe, the posterior precommissural region and the anterior portion of the supraoptic region. The first three regions are undoubtedly those of sensory roots. The last-named region may include emergent preganglionic fibers.

**Acute Suppurative Frontal Sinusitis: Intracranial Complications.** Dr. J. H. Maxwell, Ann Arbor, Mich.

Dr. Maxwell ascribed many of the complications of acute frontal sinusitis to inadequate therapy applied too late, insufficient amounts of antibiotics, the use of drugs not specific for the type of infection present and rapid extension of the infection beyond the natural boundaries of the sinus. The last-named condition is most likely to occur in fulminating infections due to Hemophilus influenzae or after acute exanthems or swimming. In very young children one finds that extracranial accumulations of pus are the commonest complication. An acute exacerbation of the chronic condition is more likely to produce osteomyelitis. He described the extracranial complications and discussed the differential diagnosis of frontal lobe abscess, subdural abscess and epidural abscess. Diagnostic trephine, ventriculography and exploratory tapping may be necessary to locate the focus accurately. Surgical procedure at first may have to be limited to release of accumulated pus, with radical excision to follow after the process has been well delimited.

**Pathology of Acute Suppurative Sinusitis.** Dr. B. J. McMahon, St. Louis.

Dr. McMahon discussed the factors predisposing to complications. The size of the sinus, disposition of its compartments and the direction and patency of its duct have much to do with the matter of drainage. Thrombosis of venules with retrograde extension by way of the

diploe are prime factors in the spread of the infection to the bone and into the cranial cavity. One may have a periostitis, an osteitis or an osteomyelitis, depending on the degree of the infection and the tissues involved. While the pathological picture may be appreciably influenced by the administration of antibiotics, one must be on guard not to be lulled into a false sense of security. The process, though limited by the drugs, may nevertheless have already caused irreversible damage.

**Treatment of Acute Frontal Sinusitis.** Dr. R. L. Goodale, Boston.

Treatment depends on a proper evaluation of the individual case. Anatomic factors and the degree and type of infection influence the course of the disease. Palliative therapy is successful in most cases. However, when the symptoms are severe and fail to abate promptly, a trephine opening through the floor is recommended. It is important that the case be closely followed to complete resolution, lest foci be left unhealed, thereby predisposing to recurrence or chronicity. Antibiotics and sulfonamides play an important role, in both early therapy and in surgical cases, but they must not be relied on entirely to the exclusion of operative procedure when the latter is indicated. Recurring attacks may call for radical surgery, in which case the type of operation will depend on the degree of destruction and the status of the duct. If the duct is capable of functioning, it should not be traumatized. If it is beyond repair, it may be necessary to perform an obliterating operation.

DISCUSSION

Dr. Harris P. Mosher offered a number of pertinent comments on the above papers, based on his own experience and observation. These comments may be summarized as follows:

The fundamental element in chronic infections is an infectious thrombophlebitis.

Severe or intractable acute cases will respond to a trephine opening in the floor of the sinus.

The Lynch operation is successful for small shallow sinuses but often fails to afford access for removal of diseased mucosa in remote pockets of extensively pneumatized sinuses.

Dr. Maxwell's statement that "an intracranial infection may complicate an acute frontal sinusitis even before an actual empyema of the sinus has time to develop" merits emphasis.

In acutely ill patients it may be necessary to do an exploratory operation even before roentgenographic evidence of bone destruction is available. Localized accumulations of pus must be drained.

If necrosis or perforation of the anterior wall is present in acute frontal sinusitis one is justified in removing enough of the posterior wall to exclude extradural abscess, since these are frequently symptomless and may lead to osteomyelitis and other complications.

The obliterating operation that appeals to Dr. Mosher is the one in which both anterior and posterior walls of the sinus are removed, leaving the floor intact and the duct undisturbed except for a packing with a gelatin sponge soaked in thrombin. The anterior ethmoid cells are removed; the posterior ethmoid cells are removed only if roentgenograms show pronounced disease. The inner half of the incision is left open and the cavity packed. Obliteration is accomplished through the granulations from the dura and bone edges. Repeated packs assure healing from the bottom. The resulting cosmetic deformity is corrected at a later date.

The most vital point in chemotherapy is the determination of the sensitivity of the offending organisms.

**Choice of Treatment in Cancer of the Larynx in 1949.** Dr. Daniel S. Cunning, New York.

Dr. Cunning stated that his early skepticism with regard to the value of irradiation in carcinoma of the larynx was dispelled after witnessing a cure by this method in patients for whom he had recommended a laryngofissure. Since then he has observed 33 patients similarly

treated and followed up; 27 are living and well today, although the majority are still under the five year mark. Selection of cases for radiotherapy depends on the size, location and morphological study of the growth. Strict limitation of the neoplasm to one cord without deep invasion is more important than the question of radiosensitivity. Growths of extrinsic cancer formerly considered inoperable respond favorably in certain instances and may later become operable, if necessary. Details of the technic were given. Metastatic nodes secondary to lesions of the cord or subglottic region were treated by block dissection. Roentgen ray therapy, however, was considered preferable in cases in which the nodes were secondary to involvement of the epiglottis or false cords.

DISCUSSION

Dr. Paul Holinger expressed the belief that most surgeons are in agreement that the therapy of choice in extensive lesions should be surgical. As for the early lesions, experience has proved the value of operation in a high percentage of the cases. While irradiation technics have improved, the process may still be considered to be in the experimental stage and will require at least 10 or 15 years more for proper evaluation. Dr. Holinger also pointed out that in Dr. Cunning's group of 33 patients, 20 per cent had died and the remainder were still under the five year postoperative limit. These results do not compare favorably with the 80 per cent attaining the rate of five year cure by laryngofissure, as recorded by several observers. It has also been his experience that laryngectomy after irradiation is not as favorable as primary laryngectomy.

Dr. Louis H. Clerf also expressed concern over the high percentage of Dr. Cunning's group still on the "sunny side of even three years" postoperative life. He agreed with the speaker that much depends on the skill and experience of the radiologist. The same can be said of the surgeon when discussing medications and results. His experience with operation following irradiation, like that of Dr. Holinger, has also been unfavorable. The combination of radical surgery plus block dissection has yielded good results when all the affected tissues have been extirpated. His experience with irradiation of cervical nodes has not been a happy one, and he prefers not to use it. He still believes that the subject is unsettled because of the complexity of the rules that various radiologists and some surgeons lay down.

Dr. Gabriel Tucker expressed agreement with the previous speakers. He inquired of Dr. Cunning whether the patients treated by irradiation were past the age of 65. It has been his experience that patients past the age of 65 were less favorable risks than younger subjects and, consequently, might be more suitable for radiation therapy.

Dr. Thomas C. Galloway pointed out the danger of citing statistics based on observation under five years. Coutard's early report in 1931 of 26 per cent for a five year rate of cure had to be modified to show that in one third of the reported cases of cures there were recurrences. This observation brings up the question whether the five year limit is sufficient.

Dr. M. C. Meyerson stated that the important thing is that the surgeon do the best for his patient, not only from the standpoint of eliminating the disease but also with full consideration of possible suffering and discomfort, which may be the result of the therapy. This observation is particularly true in the case of radiation therapy, which is attended with more prolonged pain than is laryngofissure.

Dr. D. S. Cunning laid no claims to finality in presenting his series of cases. The presentation was made merely to point out some of the advantages of irradiation in certain selected cases. As for the age of his patients, hardly any of them were over 65. He agreed with Dr. Galloway that one can never be sure the cancer is entirely eliminated, citing a case in which the patient with a successful laryngectomy died of pulmonary metastases 17 years later. He expressed his desire to follow his cases in years to come and to supply further information concerning the eventual outcome. Dr. Cunning said that he liked to operate as well as any of the speakers but that he is also trying to be honest and to give the new therapy a chance.

**Removal of Carcinoma of the Larynx with Immediate Skin Graft for Repair.** Dr. Frederick A. Figi, Rochester, Minn.

Dr. Figi stated that whenever it is possible to extirpate completely a malignant growth of the larynx without sacrificing the entire organ, such a procedure would be most acceptable to the patient. The difficulty arises in determining when laryngectomy is absolutely the only measure to be considered in a specific case as against a more conservative operation. Frequently, the issue cannot be settled until the larynx is divided and open for direct inspection. Dr. Figi has found certain borderline cases of growth that might normally be subjected to a laryngectomy, amenable to extensive resection via laryngotomy. Since this procedure leaves an extensive raw surface, immediate lining of the defect with a skin graft hastens the recovery and leads to an early satisfactory end result. This procedure was followed in three cases cited with good results. Great care must be exercised to see that the lesion is completely extirpated, which procedure can be controlled by frozen sections from adjacent areas before the graft is applied.

DISCUSSION

Dr. Gabriel Tucker has found an early tracheotomy to be of value in determining what operative procedure should be followed, since it puts the larynx at rest, permits inflammatory reactions to subside and affords an opportunity for inspection of the lesion via retrograde laryngoscopy. Certainly, conservative surgery is preferable to radical excision, not only because of the voice but because the protective mechanism of the larynx with respect to the lower respiratory tract, is preserved.

Dr. F. A. Figi agreed that retrograde laryngoscopy had its advantages. However, he was not favorably inclined toward the two stage procedure suggested by Dr. Tucker, preferring to carry out the surgery indicated after direct inspection via the thyrotomy. In cases in which the lesion involves the epiglottis and supraglottic portions of the larynx, he resorts to diathermy excision via the Lynch suspension exposure. The results have been eminently satisfactory.

**Rehabilitation of the Laryngectomized Patient.** Dr. Leroy A. Schall, Boston.

Dr. Schall presented a moving picture showing the steps in the rehabilitation of the laryngectomized patient at the Massachusetts Eye and Ear Infirmary. Instruction in developing esophageal speech was given to more than 100 patients by a former language correction teacher whose larynx had been removed five years previously. Instruction begins even before the operation and is carried out soon afterward, singly and in groups. The instruction is free, and the results, as demonstrated in the film, fully justify the time and effort.

**Surgical Correction of Cicatricial Stenosis of the Larynx.** Dr. Fletcher D. Woodward, Charlottesville, Va.

Dr. Woodward described an operation successfully carried out in four cases of laryngeal stenosis due to trauma, disease and previous operation. The procedure consists of a median thyrotomy, removal of all scar tissue, fixation by means of through-and-through wires of a hollow perforated acrylic tube within the larynx and implantation of a segment of hyoid bone between the severed halves of the thyroid cartilage to widen the constricted larynx.

**The Present Status and the Future of Otolaryngology.** Dr. Dean M. Lierle, Iowa City, Ia.

Dr. Lierle reviewed the history of the development of otolaryngology as a specialty, the progress it made over a period of years and the recent trends in therapy and practice whereby the field has become constricted. Limitation of surgical indications resulting from the use of antibiotics, encroachment by general practitioners and bordering specialties account in some

measure for this limitation of opportunity. However, a survey by a committee of the Board of Otolaryngology, as well as the experience of the last war, has shown a lack of proper training among a large number of otolaryngologists owing to a lack of uniformity in curriculums of various teaching institutions. Such subjects as peroral endoscopy, maxillofacial surgery and surgery of the neck have been inadequately presented. If the specialty is to serve its purpose it is important that young men entering the field be provided with adequate facilities for obtaining instruction in these fields. Treatment of trauma and plastic procedures of the organs treated in the specialty must be a part of the specialist's training. The teachers' section of the Academy should be revived so that the ideas may be interchanged regarding the standardization of instruction in the broader aspects of otolaryngology, in order that the specialty may continue to grow and expand to meet changing conditions.

DISCUSSION

Dr. Burt R. Shurley commented on the influence of newspapers and other periodicals on the lay mind with reference to medical problems. He cited the fear of tonsillectomy during the poliomyelitis season, which has been overexaggerated. In his own experience with more than 20,000 tonsillectomies, he has never had a case of poliomyelitis attributable to previous tonsillectomy come to his attention.

He agreed with Dr. Lierle that the training of an otolaryngologist today involves considerably more than it did in the previous generation and that, consequently, there is need for a broader and more detailed curriculum than heretofore.

Dr. Harris P. Mosher was impressed with the wealth of material covered by the speaker and recommended that the paper be thoroughly studied by all who are concerned with the instruction of aspiring otolaryngologists.

Dr. Albert C. Furstenberg commented on the widespread feeling among medical students and internes that otolaryngology is a dying specialty. Suggestions as to how to counteract this impression should include greater stress on research, since no specialty can advance without adequate investigation of unsolved problems. In line with Dr. Lierle's comment on the inadequacy of training in some institutions, Dr. Furstenberg pointed out that the current survey of medical schools by a committee of the Association of Medical Colleges and the American Medical Association gives promise of yielding fruitful results so far as improving these conditions is concerned.

Dr. Norton Canfield mentioned another factor that tends to limit the opportunities for training internes and residents in otolaryngology, namely, the policy of certain hospitals of restricting the number of beds available for ear, nose and throat patients because of pressure on the part of other specialties which are more profitable to the hospital. Also, since ear, nose and throat cases are generally of the elective type, the competition for beds generally works to our disadvantage. As a result, the house staff sees fewer cases in our field than is their due in relationship to the total hospital population.

Dr. Gordon D. Hoople stated that the impression that otolaryngology is a dying specialty is the fault of ourselves in submitting to it. One must admit that the specialty is a changing one, and we must be alert to develop those avenues which recent scientific progress have opened up to us.

Dr. D. M. Lierle agreed that we must dismiss the notion of a dying specialty as unworthy and contrary to fact. The dearth of residents which one of the discussers mentioned is not to be attributed entirely to lack of opportunity or enthusiasm. One important factor is the competition from the Army, Navy and Veterans Hospitals, which offer considerably more pay to residents than private or civic hospitals. Young married men entering residencies must be provided with a decent living wage. Finally, it is up to teaching institutions to offer adequate broad training in the newer procedures, such as allergy, plastic surgery and modern otology.

**The Modern Role of the Rhinologist in the Diagnosis and Therapy of the Cause of Head Pain.** Dr. Lawrence R. Boies, Minneapolis.

Head pain is produced in one of three possible ways, namely, by change in cerebral blood volume, by direct irritation of sensory nerves and by the localized effect of histamine. A classification of headaches was offered, embracing those due to systemic or general disorders, those due to disorders within the head and those arising from disturbances of the vascular and muscular structures about the head. The details of these various types are gone into with an explanation of their mechanism. All this is important in proper differentiation, so that the indications for therapy may be accurately outlined.

DISCUSSION

Dr. John J. Shea called attention to the value of angiograms in certain types of conditions usually refractory to ordinary treatment. He showed slides of cases in which were depicted several intracranial lesions previously undiagnosed.

Dr. M. C. Meyerson mentioned latent or undiagnosed sinusitis as a cause of headache and described two typical cases of obstinate headache unsuccessfully treated over long periods of time, which were finally traced to isolated empyema in several ethmoid cells.

Dr. Jerome Hilger pointed out that rhinologists have inherited these obscure cases because of failure of internists and neurologists to determine the true cause. Failing to ascribe the headache to a rhinologic cause, we have been forced to go into these cases more deeply, with the result that thorough study has frequently resulted in the answer.

A typical neuralgia is vascular pain, and the causes of the vascular disturbance may be several. The role of histamine in the production should not be overlooked, any more than it should be overemphasized. Certainly, the study of arteriolar spasm is an important factor in the comprehension of vascular headache. Such study must embrace a careful analysis of the basic patterns of the individual patient, whereby a knowledge of the inherited tendencies may be elicited.

Dr. Benton N. Colver corroborated Dr. Meyerson's experience, citing a case in which an obstinate hemicrania was finally traced to a silent empyema in a posterior ethmoid cell.

Dr. L. R. Boies stated that he also had had experiences similar to those cited by Meyerson and Colver. However, such cases are exceptions, since an analysis of several hundred cases of headache revealed that only 3 per cent were due to disease of the nasal spaces.

**Effect of Cortisone on Idiopathic Granuloma of the Midline Tissues of the Face.** Dr. Henry L. Williams, Rochester, Minn.

Dr. Williams presented a case of malignant granuloma of the face in which temporary improvement was noted following the administration of cortisone (11-dehydro-17-hydroxy-corticosterone). The most noticeable improvement was in the general well-being of the patient, with relief from pain and tenderness and improvement in appetite. Also, the secretions became more profuse and thinner, and the granulomatous tissue seemed to recede somewhat. Tenderness of the temporal artery, however, was present for a short time, suggesting a vascular effect of the drug. Although healing was observed, the progress was very slow and was not sustained. Nevertheless, the cortisone did seem to effect changes that could be attributed to metabolic influences.

DISCUSSION

Dr. J. J. Hochfilzer, who was associated with Dr. Williams in the case cited, gave a detailed description of the roentgenologic and pathological findings.

Dr. Harry P. Schenck reported apparent remission in a recent case following roentgen ray treatment. However, as with all other forms of therapy previously reported, the improvement was only temporary. One of the puzzling aspects of the disease is the fact that the cause is still obscure, despite the fact that the histological picture is characteristic and well recognizable.

Dr. Walter B. Hoover, commenting on the known tendency of the hormone of the anterior lobe of the pituitary to inhibit granulations, asked the question whether healing is promoted or retarded at the same time.

Dr. Francis L. Weille stated that to his knowledge there has been no publication in the literature of the ear, nose and throat concerning the subject of cortisone or pituitary adrenocorticotropic hormone (ACTH), this one of Dr. Williams' being the first. Certainly, one may look forward to more interest in the subject so far as our specialty is concerned. He asked for information on the subject of toxic effects of the drug and also whether the type of preparation in use has been changed or improved.

Dr. Sam Roberts brought up the question of mineral deficiency as an etiologic factor, noting that Dr. Williams' patient seemed to improve as much with potassium as with the cortisone. Also, the pictures of the patient showed a few straggly teeth, suggesting a deficiency disease. In groping for the true cause, one must not overlook even the most obvious factors.

Dr. Thomas C. Galloway spoke of a similar case that he had observed, in which an anaerobic microaerophilic organism was found. The lesion was exposed and treated with zinc peroxide, and it healed, at least superficially. Deeper extension into the orbit and pterygomaxillary fossa, however, prohibited the exposure of the disease to the solution, and the condition ultimately became worse.

Dr. H. L. Williams stated that so far as he was able to learn, the hormone of the anterior lobe of the pituitary stimulates the production of the adrenal cortical hormones, of which cortisone is one. Experimentally, the drug will discourage formation of granulation tissue in wounds. The toxic effects of the drug were fully covered in the paper. As for Dr. Roberts' comment on the need for minerals in diets, Dr. Williams stated that he was aware of the widespread administration of mineral supplements by farmers to their live stock, and he often wondered why the physicians in those areas never thought of giving them to their patients. He agreed with Dr. Galloway that anaerobic bacteria are frequently present, but since they are penicillin sensitive he could see no advantage in the open treatment with zinc solutions.

Having in these few days listened to five papers on the subject of autonomic dysfunction, Dr. Williams was interested in the problem of vasoconstriction as an etiologic factor of certain disorders and, particularly as a factor in connection with the problem of the case he presented. However, he was not to be led astray by placing too much reliance on any one vasodilator as a panacea for the correction of the disorder. Experience has shown that certain vasodilators are more effective in certain persons than in others, for reasons which are as yet unexplained.

**Cochliomyia Americana Infestation in Man.** Dr. H. Marshall Taylor, Jacksonville, Fla.

Dr. Taylor described infestation of the human being by screwworm as an insidious, fearful disease causing great suffering and destruction of tissues and ending fatally in a high percentage of cases, the mortality being reported as varying from 15 to 35 per cent in various tables of statistics. Usually, the insect gains entrance via the upper air passages and develops in the nose, sinuses, mouth and throat. It may also enter through an external skin lesion. As a rule, there is a history of some previous local infection. The organism rarely attacks healthy tissues. Dr. Taylor had seen eight cases of this malady and has described the course in one recent case, in which the nose, sinuses, teeth, palate and tonsils were all infested, the infestation causing swelling, foul discharge, severe pains and toxemia. The diagnosis is made by examination of the discharge for larvae. At times, the insects may actually be seen moving about in the cavities involved. Therapy should be prophylactic as well as remedial. Proper sanitation and control of the disease in animals will lessen the likelihood of man becoming infected. Treatment of the disease proper is chiefly symptomatic, although chloroform administered locally and in vapor has been found useful in killing off all the insects that can be reached by the drug.

**Smoker's Larynx: A Clinical Pathological Entity.** Dr. M. C. Meyerson, Beverly Hills, Calif.

Dr. Meyerson described a condition of the larynx of smokers, which, he believes, is a distinct entity. He observed the condition in 143 patients, 14 of whom were women, the ages ranging

from 16 to 69. Clinically, it is recognized by a history of vocal fatigue and long-standing hoarseness of varying degree in persons who smoke to excess. Occasionally, dyspnea may be present, and in one case a tracheotomy was required. Of interest is the fact that many of the patients were men with heavy short necks; locally, the lesion observed was generally a bilateral edema of the vocal cords. Edema may be localized to one or both cords and involve either a segment or the entire length of the cord. Later, fibrosis may take place.

Vocal rest and abstinence from smoking may lead to resorption only in very early cases. Most patients will require operation, which consists in removal of the edematous mucosa.

DISCUSSION

Dr. Louis H. Clerf stated that the local effects of excessive smoking are not confined to the vocal cords, since changes in the palate, uvula and pharyngeal mucosa are quite characteristic. He did not think that the lesion described by Dr. Meyerson should be termed a fibroma. The condition is generally an edematous one, involving the cords but never extending to the vocal process. Also, it is seen only in certain persons who are apparently sensitive to the irritants in tobacco.

Dr. Gabriel Tucker said he has seen this condition occasionally in persons who do not smoke. However, he agreed that smoking aggravates the condition.

Dr. Ralph Fenton added that he personally represented the "horrible example" of the bad effects of smoking described by Dr. John Meyers some years ago. He could attest to the value of abstinence in the cure.

Dr. M. C. Meyerson discussed the question of the histopathology that was mentioned by Dr. Clerf. Pathologists whom he consulted agreed that the specimens were fibrous and edematous and could, therefore, be called edematous fibroma.

As for similar lesions being found in nonsmokers, it is true that vocal abuse can produce a vascular polyp, hemangioma or Imperatori's varix. These growths are usually purplish red or purple and certainly do not resemble the lesion he has described in the paper. There is one condition, however, which may closely resemble it, namely, the isolated edema of the cords occasionally seen in tuberculosis.

**Papilloma of the Larynx.** Dr. Paul H. Holinger, Chicago.

Dr. Holinger presented an analysis of 109 cases of papilloma of the larynx observed during the past 15 years. This analysis included a review of the etiology, symptomatology and histopathology of the condition and a discussion of the various therapeutic measures that have been used from time to time. Aureomycin was tried in seven children, with encouraging results. This drug was used because of its known specificity for virus disease. However, the time of observation is too brief to permit drawing final conclusions.

DISCUSSION

Dr. John H. Foster reported favorable results from the use of nonlethal doses of roentgen rays, particularly in children. The dose must be small, averaging about 75 r. Whether the effect of the irradiation is due to stimulation or ionization is not clear. If papillomas are caused by a virus, as is generally assumed, it is likely that the aureomycin therapy may prove very successful.

Dr. Francis E. Lejeune also has had good results from the use of small doses of roentgen rays. In some cases it is advisable to do a tracheotomy and put the larynx at rest.

Dr. Edwin N. Broyles commented on the experiments performed for the isolation of a filtrable virus assumed to be the cause of the growths, but with inconclusive results. Because changes take place in the papillomas at the age of puberty, Dr. Broyles feels that the hormone theory has merit, although results with estrogens have not been too encouraging.

Dr. E. V. Ullman recalled some experiments he performed 27 years ago under the inspiration of Professor Pirquet. Successful takes were obtained in three of five cases, demonstrating the virus. This result leads him to suspect that other factors may play a part in the etiology. At any rate, the apparent success of aureomycin would seem to substantiate the virus theory.

DR. RICHARDSON reported a condition in a 2½ year old child who was operated on and then given aureomycin with no improvement. Later the child was operated on again and was given chloramphenicol (chloromycetin®). Intralaryngeal irradiation was being considered.

DR. P. H. HOLINGER expressed surprise at the small doses of roentgen rays used by DR. Foster in his cases. Concerning early tracheotomy, he wondered whether it really does much good. It would be interesting to compare statistics of parallel groups of those who were tracheotomized and those who were not. Dr. Broyles' work with estrogens is very significant and should not be dismissed because of inconclusive results. Dr. Ullman's work is very well known and is of high significance.

Dr. Holinger tried radon suspended within the larynx for a few minutes, but discontinued the attempt through fear of possible damage from the irradiation.

The aureomycin therapy is still in the experimental stage, with much to be learned as to dosage and effects, but it gives sufficient promise to make its continuance worth while.

# News and Comment

## UNIVERSITY OF ILLINOIS INITIATES MODIFIED PROGRAM

For the period of the national emergency, the University of Illinois College of Medicine will offer a combined three year residency training program in otolaryngology, which will include the basic course material in fulfilment of Board requirements.

Residents will be rotated through the Research and Educational Hospitals, the Illinois Eye and Ear Infirmary, the Hines Veterans Administration Hospital and the various affiliated institutions. The residency will be so flexible that should it be interrupted because of military service the period of training may be resumed on the student's return to civilian life.

Under this arrangement no course fee is to be involved, and in the case of most of the aforementioned institutions, a stipend is provided.

Further information may be secured from the Head of the Department of Otolaryngology, University of Illinois College of Medicine, 1853 West Polk Street, Chicago 12, Ill.

## SCHOLARSHIP FOR STUDENTS OF LIPREADING

The American Hearing Society announces that applications are being received for the Kenfield Memorial Scholarship for 1951, which amounts to $100.00. Application for the scholarship will be considered from any resident of the United States who desires to teach lipreading (speechreading) to the hard of hearing with or without other types of hearing and speech therapy. Those persons already teaching lipreading cannot be considered.

The applicant should be a college graduate with a major in education, psychology and/or speech, together with professional training in lipreading. If the applicant is hard of hearing, 30 clock hours of private instruction under an approved teacher of lipreading or 60 clock hours of instruction in public school classes under an approved teacher of lipreading are required.

The winner of the scholarship may take the training course from any normal training teacher, school or university in the United States offering a course acceptable to the Teachers' Committee of the American Hearing Society. The scholarship must be used within one year from the date the award is made.

Applications must be filed between March 1 and May 1, 1951, with Miss Rose V. Feilbach, Chairman of the Teachers' Committee, 1157 North Columbus Street, Arlington, Va.

# Book Reviews

**Common Diseases of the Ear, Nose and Throat.** By Philip Reading, M. S. (Lond.), F. R. C. S. (Eng.), Surgeon to Ear and Throat Department, Guy's Hospital. Price, $4.50. Pp. 288, with 2 colored plates and 37 illustrations. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, Pa., 1950.

This short book demonstrates well the status of otolaryngology in Great Britain. It has been designed particularly for the student and general practitioner. However, it presents in a simple and direct style material that might well be reviewed by even the specialists. The contents are systematically presented, but to be regretted is the absence of any bibliography and the apparent lack of newer concepts of treatment and procedures. This book has been rather well done, and for the purpose with which it has been presented it can be recommended. The illustrations supplement the material in the text well, particularly the black and white line drawings.

**A Bibliograhy in Audition.** Two volumes. Compiled by George A. Miller, Robert Galambos, Walter Rosenblith and Ira Hirsh. Bibliography by Mrs. S. Hirsh. Price, $3. Harvard University Press, Cambridge 38, Mass., 1950.

These volumes are extremely vital contributions to the field of otology. The work was done at the Psycho-Acoustic Laboratory under contract for the Office of Naval Research. They indicate alphabetical listings, giving references by authors and subjects. There is complete coverage of the literature from 1938 to 1948, with a supplement of major contributions up to January 1950. There is a reasonably good inclusion of the literature prior to 1938. In total, there are about 5,500 entries, 65 per cent of which were published after 1938.

The authors have made available a very complete bibliography to men doing research in the field. Much time and effort will be saved as a result of this contribution, and the project has been worth while. The volumes should be available to everyone interested in the field of hearing.

**Introduction to Oto-Rhino-Laryngology.** By Paul Falk, M.D., Professor of Oto-Rhino-Laryngology and Director of the Ear, Nose and Throat Clinic of the University of Saarlands, Homburg. Second edition. Price 19.80 German marks. Pp. 179, with 150 illustrations, many in color. George Thieme Verlag, Diemershaldenstrasse 47, Stuttgart, Germany, 1950.

This excellent book deals essentially with anatomy, physiology and methods of examination. Each chapter is subdivided into these categories. Under anatomy, particularly in the chapter dealing with the ear, considerable emphasis has been placed on neuroanatomy. The illustrations, many of which are in color, beautifully describe both normal and abnormal conditions found in routine examination and also the anatomic relationships. Considerable emphasis is laid on methods of examination.

No attempt has been made in this treatise to discuss specific pathologic conditions, nor is any attempt made to outline treatment. This is an excellent book for use by students, and particularly postgraduate students in otolaryngology, since it presents a comprehensive discussion of practically all basic factors in this field.

**Contribution to the Treatment of Deafness.** By Guilherme Penha, M.D. Price not given. Pp. 712, with 164 illustrations, many in color and numerous audiograms. Coimbra Press, Coimbra, Portugal, 1950. (in Portugese.)

This thesis encompasses a complete review of present day knowledge of deafness. In the first chapter Penha presents a historical review of all etiopathologic factors of otosclerosis. The second chapter deals with surgery. The technics of all prominent surgeons are given in great detail. These are profusely amplified by clearly descriptive illustrations and color plates. Many modifications are described, including the author's technique. Chapter 3 deals with medical treatment,

and future experimental problems are discussed in chapter 4. A whole chapter is devoted to the question of Ménière's syndrome and its relation to otosclerosis. There is a fine summary (in four languages) emphasizing the most significant features of the presentation. Lastly, there is a most extensive bibliography. All in all, this book is one of the most valuable presentations and should be a "must" for every otologist, particularly for those who are interested in otosclerosis.

**Broncho-Esophagology and Gastroscopy.** By Chevalier Jackson and C. L. Jackson. Japanese translation, third edition, by Dr. Jo Ono. Gakujutsu, Tokyo, Japan, 1950.

Translation of this authoritative work by the Jacksons, which has already been published in French, Italian and Spanish, now appears in Japanese. The translation was done by Dr. Jo Ono, the visiting professor of bronchoesophagology, Keio University Medical School.

Dr. Ono is an alumnus of Jefferson Medical College. On completion of his preliminary medical education he spent a number of years under Dr. Louis Clerf in endoscopic practice. Since returning to his native Japan he has devoted his efforts to the field of bronchoesophagology. Thus, by both training and experience Dr. Ono is eminently fitted to undertake this task of translating Jacksons' writing into Japanese.

Dr. Ono states in the introduction of this edition that Dr. Jackson contributed more than 70 halftone cuts, including a colored print, depicting 18 different conditions as seen through the peroral endoscopes, for the benefit of the Japanese edition. The colored plate appears on the front page of this edition; all other illustrations appear in black and white. The Japanese edition includes the presentation of bronchopulmonary segments by Jackson and Huber. To those familiar with the original American edition the absence of the numerous colored illustrations by Jackson's own brush in this Japanese edition gives an impression that the work lacks a finished touch. There was dearth of printing materials in the postbellum days in Japan.

It is precisely and accurately translated into scientific language which the Japanese practitioners can readily understand. The entire work covers 39 chapters and 461 pages, as in the original. Dr. Ono and his publishers are to be congratulated for their splendid contribution in Japanese.

# Directory of Otolaryngological Societies *

## NATIONAL

### American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. J. Milton Robb, 1553 Woodward Ave., Detroit 26.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis 3, Tenn.
Place: Atlantic City, N. J. Time: June 13-15, 1951.

### American Academy of Ophthalmology and Otolaryngology

President: Dr. Derrick Vail, 700 N. Michigan Avenue, Chicago 11, Ill.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn

### American Board of Otolaryngology

Secretary: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Place: Hotel Biltmore, New York. Time: Jan. 8-11, 1951.
The John Marshall Hotel, Richmond, Va. Time: May 1-4, 1951.

### American Broncho-Esophagological Association

President: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Secretary: Dr. Edwin N. Broyles, 1100 N. Charles St., Baltimore 1.
Place: The Claridge Hotel, Atlantic City, N. J. Time: May 7 and 8, 1951 (p. m.).

### American Laryngological Association

President: Dr. Gordon B. New, 102 2d Ave., S.W., Rochester, Minn.
Secretary: Dr. Louis H. Clerf, 128 So. 10th St., Philadelphia 7.
Place: The Claridge Hotel, Atlantic City, N. J. Time: May 9-10, 1951.

### American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Louis H. Clerf, 128 So. 10th St., Philadelphia 7.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: The Claridge Hotel, Atlantic City, N. J. Time: May 6-8, 1951 (a. m.).

*SECTIONS:*

Eastern.—Chairman: Dr. Harry P. Schenck, 326 So. 19th St., Philadelphia 3.
Place: Philadelphia. Time: Jan. 12, 1951.
Southern.—Chairman: Dr. Charles C. Grace, 145 King St., St. Augustine, Fla.
Place: Miami, Fla. Time: Jan. 17, 1951.
Middle.—Chairman: Dr. Clarence W. Engler, 2323 Prospect Ave., Cleveland.
Place: Cleveland. Time: Jan. 15, 1951.
Western.—Chairman: Dr. Lewis F. Morrison, 490 Post St., San Francisco.
Place: San Francisco. Time: Jan. 27-28, 1951.

### American Otological Society

President: Dr. Kenneth M. Day, 121 University Place, Pittsburgh.
Secretary: Dr. John R. Lindsay, 950 E. 59th St., Chicago.
Place: The Claridge Hotel, Atlantic City, N. J. Time: May 11-12, 1951.

### American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Norman N. Smith, 291 Whitney Ave., New Haven 11, Conn.
Secretary: Dr. Joseph G. Gilbert, 111 E. 61st St., New York 21.

### American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. George E. Shambaugh Jr., 55 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Joseph Hampsey, 806 May Bldg., Pittsburgh 22.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

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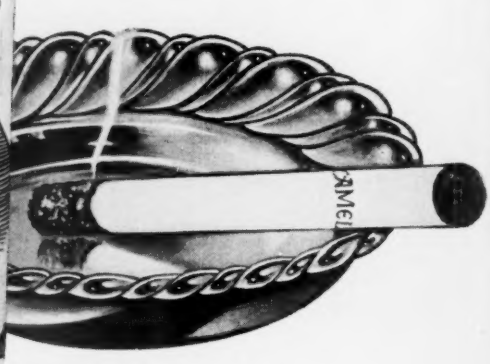

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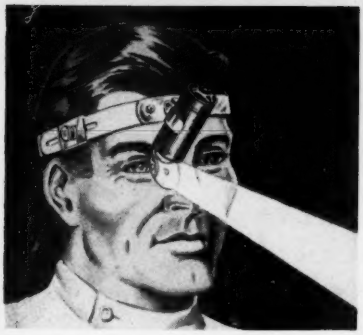

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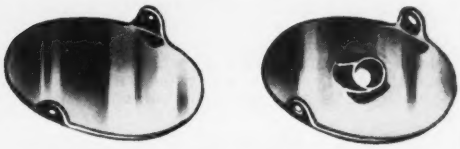

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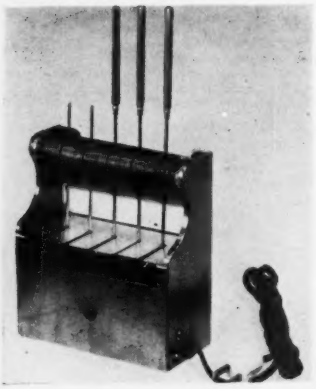

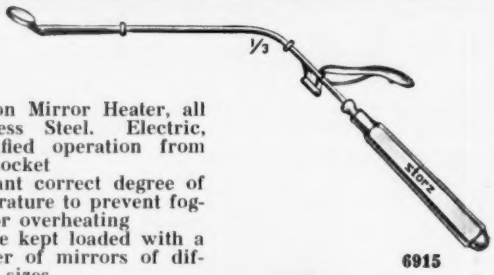


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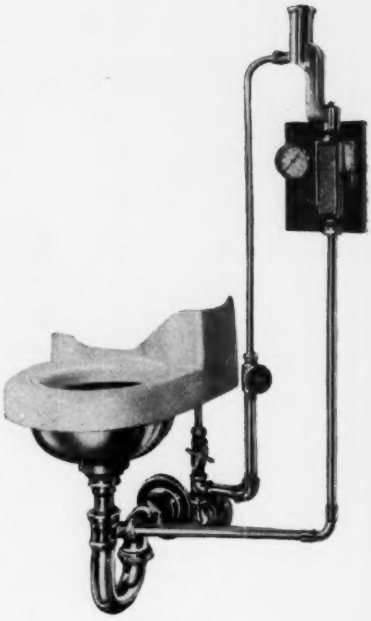

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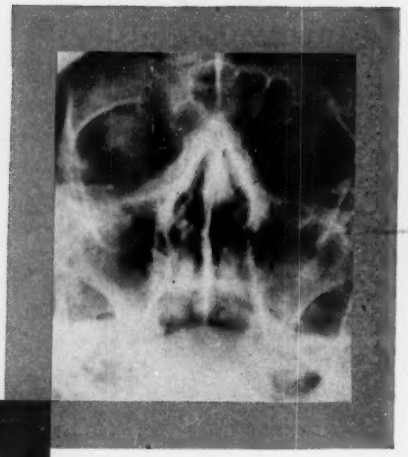

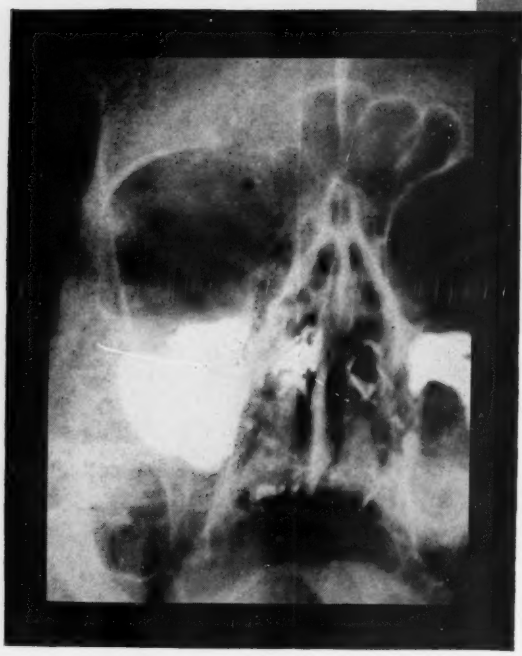

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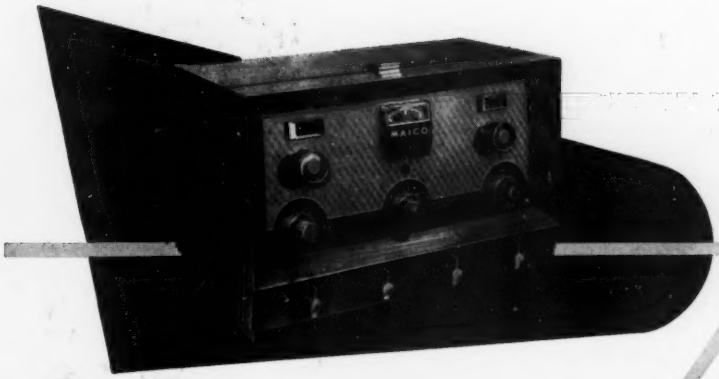

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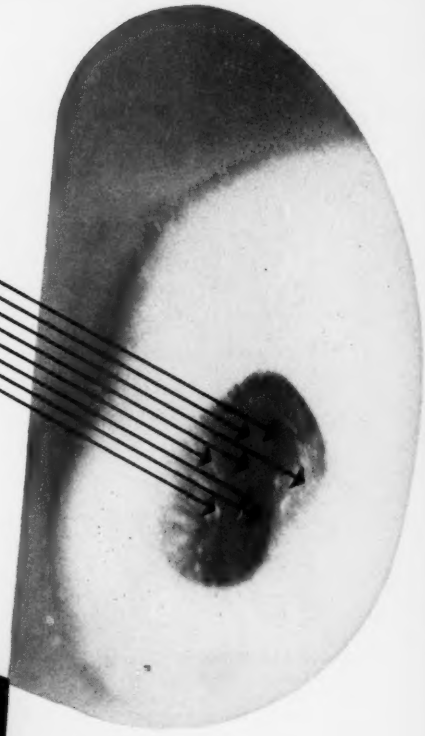

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